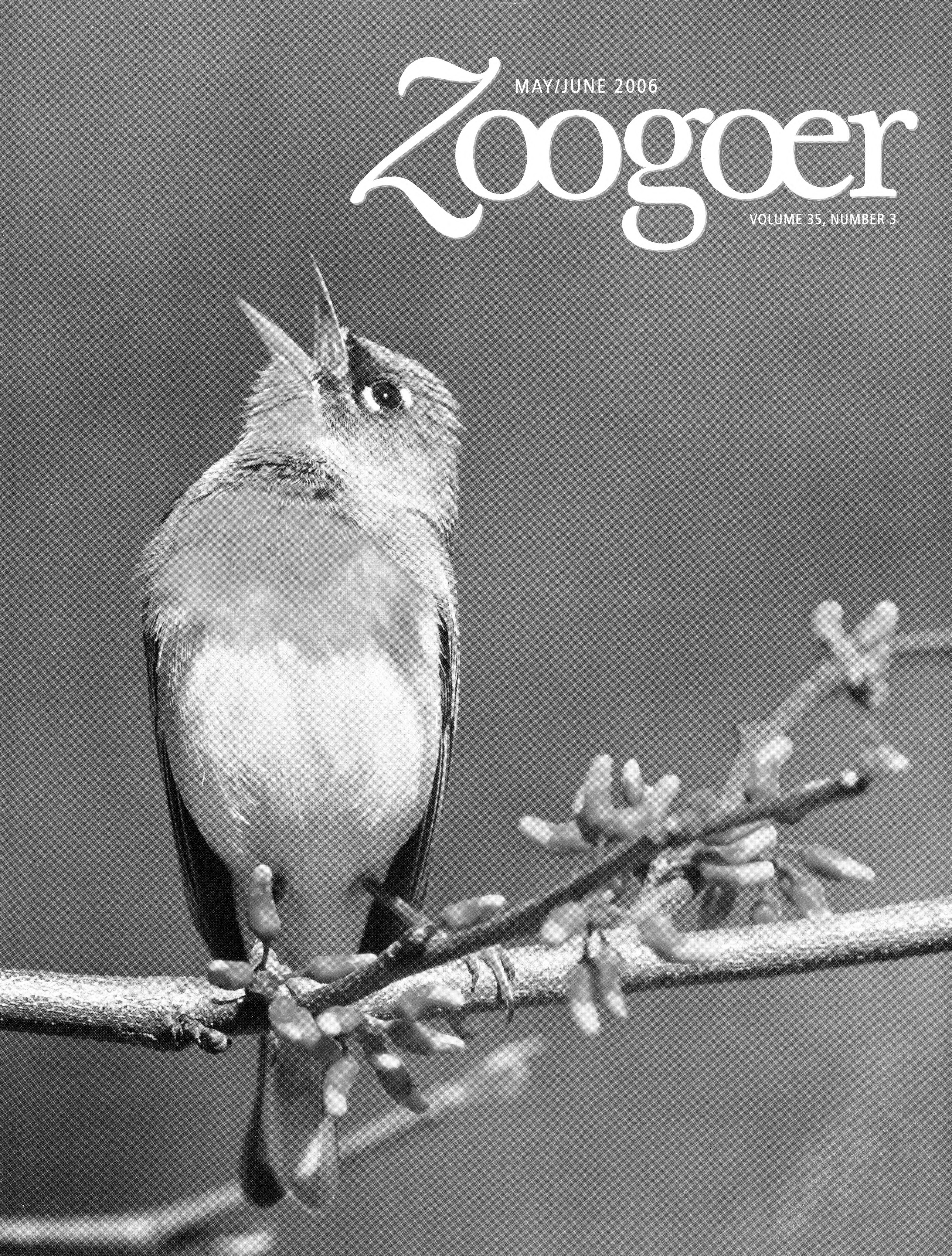
MAY/JUNE 2006

Zoogoer

VOLUME 35, NUMBER 3



Partners in Conservation Education

Among the best recognized, but rarest animals in the world, giant pandas have come to symbolize endangered species and international conservation efforts. In an effort to help protect the giant pandas and secure their future, Fujifilm is proud to be the lead corporate sponsor of the Zoo's giant panda program.

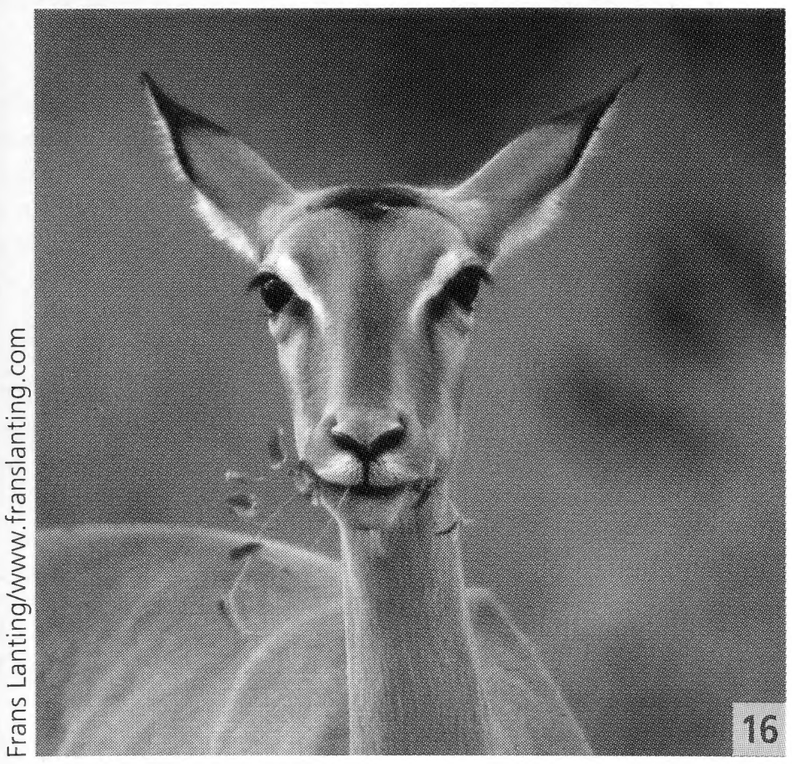
Fujifilm's support helped the National Zoo bring giant pandas Mei Xiang and Tian Tian to Washington, and is assisting the Zoo's experts to develop the scientific knowledge they need to ensure the survival of pandas in the wild. Fujifilm also supports comprehensive conservation education programs designed to help children and adults learn more about giant pandas and the conservation of all wildlife and their habitats.

Friends of the National ZOO

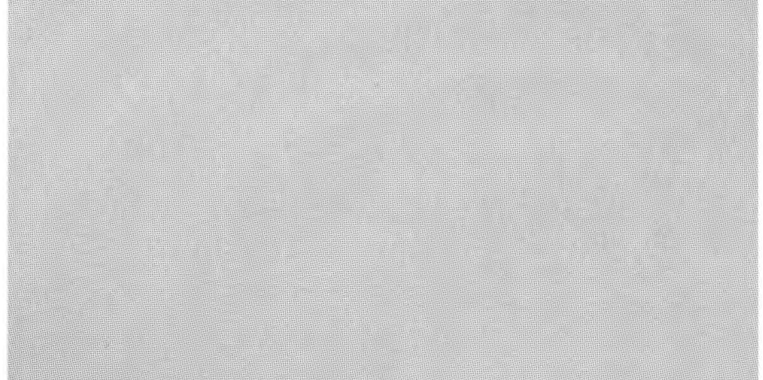
Smithsonian
National Zoological Park

FUJIFILM
Get the Picture

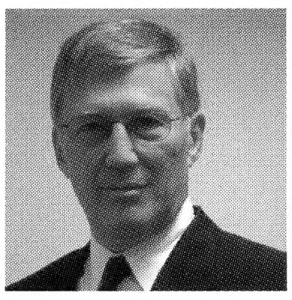
May/June 2006 | Volume 35, Number 3


Robert Royse


Frans Lanting/www.franslanting.com


Bruce Coleman Inc./Gail M. Shumway

DEPARTMENTS



FONZForum

Wild Times at the Zoo

Spring wouldn't be the same in Washington, D.C., without FONZ's annual gala fundraiser, National ZooFari. This premier evening at the beautiful Smithsonian's National Zoo has become a favorite tradition for many FONZ members, and if you're one of them I'm sure you're looking forward to it. If you haven't yet experienced this festive event, I urge you to join us this year to celebrate the Zoo's giant panda cub, Tai Shan, with a "Black & White Night." I also encourage you to come early for a chance to see the precious cub before his seven o'clock "bedtime!"

Set for May 18, Black & White Night will feature live entertainment, fabulous food from more than 100 of the area's best restaurants, including Equinox, Citronelle, Galileo, and Kinkead's, and wines from more than 20 fine vintners. A sweepstakes and silent auction offer chances to take home treasures. You'll also be able to watch special animal demonstrations and meet and talk to Zoo scientists about their groundbreaking conservation research. But ZooFari is more than just a spectacular evening at the Zoo. You can enjoy the fun and the feast knowing that your participation supports an array of important programs at the Zoo.

Last year's ZooFari raised $300,000, which helped support research on giant pandas, golden lion tamarins, Asian elephants, Eld's deer, and migratory birds. Over the years, proceeds from the event also helped fund new and improved exhibits in the Small Mammal House, construction of Amazonia and Kids' Farm, and conservation programs designed to save giant pandas, Komodo dragons, tigers, and other endangered species. This year's proceeds will be devoted to funding the completion of the Fujifilm Giant Panda Habitat, Asia Trail, and other priority National Zoo projects.

While ZooFari is the biggest, there are other special events coming up for FONZ members, too. Guppy Gala, our family-friendly fundraiser, is May 12. Kids love this event. They can climb a rock wall, watch jugglers and gymnasts, try using a jackhammer, snack on Subway sandwiches and Whole Foods apples, and meet a variety of their favorite Zoo animals.

On June 17, we have scheduled for the second year Zoo Morning, exclusively for members. Formerly ZooNight, Zoo Morning is our way of saying thank you for being such good friends of the National Zoo. A huge hit with all who attended last year and enjoyed a behind-the-scenes look at how both the staff and the animals start their day, this year's Zoo Morning promises an even greater assortment of activities and animal encounters.

Finally, every Thursday from June 29 to August 3, you can while away a warm evening at Sunset Serenades, our free summer concert series on Lion/Tiger Hill. For details on all of these events, and to purchase tickets to ZooFari and Guppy Gala, please go to our website at **www.fonz.org/events.htm**.

Of course, every visit to the National Zoo is special, whether or not there's an event. In his letter on the facing page, Zoo Director John Berry highlights some of the Zoo's newest residents. We hope you will come to see them soon and often.

Sincerely,

James M. Schroeder

James M. Schroeder
Executive Director

FONZ Friends of the National Zoo is a nonprofit organization dedicated to supporting the conservation, education, and research efforts of the Smithsonian's National Zoo. Formed in 1958, FONZ was one of the first conservation organizations in the nation's capital. Friends of the National Zoo is dedicated to supporting the National Zoo in a joint mission to study, celebrate, and protect the diversity of animals and their habitats.

ZooGoer [ISSN 0163-416X] is published bimonthly by Friends of the National Zoo (offices located at the Smithsonian's National Zoological Park, 3001 Connecticut Ave., N.W., Washington, D.C., 20008-2537) to promote its aims and programs, and to provide information about FONZ activities to its members, volunteers, and others interested in the purposes of FONZ. Periodicals postage paid at Washington, D.C. Postmaster: Send change of address to *ZooGoer*, 3001 Connecticut Ave., N.W., Washington, D.C., 20008-2537.

Smithsonian **National Zoological Park** is located at 3001 Connecticut Ave., N.W., Washington, D.C., 20008-2537. Weather permitting, the Zoo is open every day except December 25. Hours: From April 2, 2006, to October 28, 2006, grounds are open from 6 a.m. to 8 p.m.; buildings, 10 a.m. to 6 p.m. From October 29, 2006 to March 10, 2007, grounds are open from 6 a.m. to 6 p.m.; buildings, 10 a.m. to 4:30 p.m.

Membership in FONZ offers many benefits: programs, publications, discounts on shopping and events, free parking, and invitations to special programs and activities to make zoogoing more enjoyable and educational. To join, write FONZ Membership, National Zoological Park, 3001 Connecticut Ave., N.W., Washington, D.C., 20008-2537, call 202.633.3034, or go to www.fonz.org.

Membership categories and annual tax-deductible dues are:

Household	$55
Young Professional	$40
Individual	$40
Senior	$35
Contributing	$100
Sustaining	$150
Patron	$250
Sponsor	$500
Benefactor	$1000
Director's Circle	$2500
ZooGoer (for those outside a 200-mile radius of Washington, D.C.)	$30

($8 of membership dues goes to a *ZooGoer* subscription)

ZooGoer
Publisher: James M. Schroeder
Editor: Susan Lumpkin
Associate Editor: Shannon C. Lyons, email: zoogoer@fonz.org
Intern: Allison M. Hagerman
Contributing Editors: Robin Meadows, Howard Youth
Copy Editor: Jean B. McConville
Design: Free Range
Visit FONZ's website at: www.fonz.org

An audio version of *ZooGoer* is available on our website, for members who cannot read standard print due to disability. For more information, please visit **www.fonz.org/zoogoer.htm**.

On the cover: A northern parula warbler (*Parula americana*) sings on its breeding grounds in Zaleski State Forest in Ohio. Photo by Robert Royse.

Recycled paper

Accredited
The Smithsonian's National Zoo is accredited by the American Zoo and Aquarium Association.

Letter from the **Zoo Director**

Sloth Bears, Sea Lions, and More, Oh My!

Spring is beautiful in Washington, D.C., and no place is more beautiful than the Smithsonian's National Zoo. Our lush gardens are in full bloom, colorful migratory birds are nesting in our trees, and the first butterflies are appearing among the flowers. This spring at the Zoo will also be made memorable by the emergence and public debuts of some very special creatures.

In May, we look forward to our sloth bear cub and its mother leaving the seclusion of their den for the first time. Born on January 9, the cub is clearly thriving, but, as I write this near the end of March, its fiercely protective mother has yet to leave it long enough for keepers and veterinarians to give it a health exam. As a result, we still don't know the sex of this youngster!

Sloth bears exhibit a charming behavior rarely seen in other ursids: Cubs ride around on a "saddle" of thick fur that grows in a patch on their mothers' backs. Mothers are basically moveable nests, saving their cubs from using lots of energy walking between food sources—fruiting trees and termite mounds—that may be far apart in these bears' natural habitats on the Indian subcontinent. Keepers, who have been watching our new cub and its mother via a video camera, report that first-time mother Hana appeared to be curious and puzzled about what was on her back when the cub first climbed on, but she's now comfortable with her passenger.

Sloth bears are listed as vulnerable to extinction by the World Conservation Union. They are threatened primarily by habitat loss but also by poaching for their gall bladders, which are used in traditional medicine, and killing by farmers who dislike the bears raiding their crops. To help mitigate the last of these threats in India, K. Yoganand, a National Zoo research associate and FONZ-supported doctoral student, is finishing his dissertation on methods wildlife managers can use to reduce encounters between people and bears. He is now investigating why sloth bears have disappeared from parts of their range.

We're especially thrilled that our sloth bears will soon have a spacious new home on Asia Trail, scheduled to open in mid-September. Here, these bears, which are as fascinating as the famous black-and-white ones, will receive the attention they deserve.

As Zoo Director I probably shouldn't have favorites among the animals, but I have to admit that Maureen, our very old female California sea lion, has won my heart. At 29 years of age, the lovable Maureen has slowed down quite a bit and for some time she has been our sole sea lion. To liven things up, we recently welcomed two sea lion pups from the Pacific Marine Mammal Center in Laguna Beach, California, and they are expected to be ready to meet their public in May.

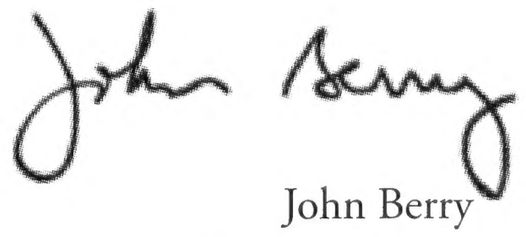
The female pups, named Summer and Calli, were born last June—Summer in Malibu, and Calli near Newport Beach. Summer was abandoned by her mother a few hours after her birth. Calli's mother suffered from domoic acid poisoning and was unable to care for her newborn. Toxic domoic acid is produced by a species of alga, and Calli's mother may have gotten a lethal dose of the poison from alga-eating anchovies she had eaten. Summer and Calli were rescued and hand-reared at the Pacific Marine Mammal Center. On their arrival here, Summer weighed 57 pounds and Calli 52; they won't reach their adult weights—175 to 200 pounds—for several more years.

Commercial hunting for their blubber and hides greatly reduced the numbers of California sea lions living along the coast of California, Mexico, and Canada during the 19th and early 20th centuries. Thanks to the protection offered by the 1972 Marine Mammal Protection Act, the species rebounded and is not considered threatened or endangered. Nonetheless, illegal killing by fishermen who consider sea lions competitors and blame them for destroying their fishing nets results in high rates of mortality. Sea lions also die when they are entangled in these nets; in fact, Maureen herself was a near-victim of net entanglement as a pup. A recent threat is the domoic acid poisoning that killed Calli's mother. Poisoning occurs when changing water conditions result in blooms of the toxic alga; in the past five years, more than 1,000 sea lions have died of it. This is an example of an emerging awareness that many species will require constant vigilance to ensure their long-term survival, even after they appear to have recovered.

I hope all of you will take advantage of warm spring days to visit the Zoo, enjoy its gardens, birds, and butterflies, and meet Summer, Calli, and our sloth bear cub. At the same time, drop in at the Small Mammal House to see the prehensile-tailed porcupine born on February 8—he's growing fast but is still incredibly cute—and the trio of banded mongooses, cat-like African striped carnivores, that arrived in February. Ours is one of only two zoos in North America where you can see these frisky creatures.

And when you do visit, be prepared for surprises, because there's always something new at your National Zoo!

Sincerely,



John Berry
Director, Smithsonian's National Zoological Park

Notes&News

Jessie Cohen/NZP

This chick was the second North Island brown kiwi ever to hatch at the National Zoo.

Animal News

For the second time in the Smithsonian National Zoo's history, a North Island brown kiwi (*Apteryx mantelli*) chick hatched at the Bird House, just one day shy of Valentine's Day. The chick's mother, Nessus, laid an egg in December and its father, Maori, incubated it for four weeks. Zoo staff then placed the egg in an incubator, where it remained for the next five weeks, except when staff weighed and candled it.

Unlike many other birds, North Island brown kiwis do not rear their offspring; for the first week of its life, the chick absorbed nutrients from an internal egg yolk, then began to eat solid foods. DNA testing will determine whether the chick is male or female.

There are five kiwi species and all are nocturnal, flightless, and live only in New Zealand. According to the World Conservation Union's Red List, North Island brown kiwis are endangered, and the National Zoo is working to ensure their long-term survival. You can see one of these fascinating birds up close at Meet-a-Kiwi keeper talks on Mondays, Wednesdays, and Fridays at 11 a.m. For more information on all the Zoo's daily programs, please visit **www.fonz.org/dailyprograms.htm**.

In May, the Zoo's baby sloth bear (*Melursus ursinus*) will likely emerge from its den, where it has been with its mother since its birth on January 9. Sloth bears use their long claws to dig ants and termites out of mounds, and will be featured on the Zoo's Asia Trail, which is scheduled to open in fall 2006.

Two California sea lion (*Zalophus californianus*) pups will also make their debut in May. Calli and Summer, both female, were rescued by the Pacific Marine Mammal Center when their mothers were unwilling or unable to care for them. The pups join Maureen, a 29-year-old female sea lion, in Beaver Valley.

Volunteer Corner

by Molly Woods

Since November 2003, Amazonia interpreters have helped visitors understand the South American rainforest ecosystem. They are unique among Zoo interpreters because they share information about "an entire region of the world," says program supervisor Bob Cmarik. Besides the rainforest ecosystem, Amazonia interpreters talk about conservation, plant life, animals ranging from monkeys to poison dart frogs to stingrays, and the exhibit's hands-on Science Gallery.

Interpreter Stephanie Spears enjoys the interactivity of Amazonia. Visitors walk through the middle of a simulated rainforest and can make their own discoveries and ask questions. For example, only sharp-eyed visitors notice the elusive female two-toed sloth in the exhibit, "proving [sloths] are well designed for camouflage." Spears is fortunate to spot the slow-moving mammal almost every time she volunteers.

For more information on becoming an interpreter in the Amazonia exhibit contact Bob Cmarik, program supervisor, at 202.633.3058 or **bob@fonz.org**. Training begins this summer.

Jessie Cohen/NZP

Amazonia volunteers work in a simulated rainforest exhibit containing animals such as poison dart frogs.

Get the scoop on Zoo scientists' latest groundbreaking discoveries at **www.fonz.org/science.htm**.

Events

It's not too late to buy tickets to two of FONZ's most beloved annual events, Guppy Gala and National ZooFari. For more information on all FONZ events or to purchase tickets, visit **www.fonz.org/events.htm**.

Guppy Gala

May 12—6 to 8:30 p.m.

Come to a special night at the Zoo for kids ages two to 12, featuring a rock-climbing wall, magicians, moonbounces, and more. Proceeds benefit National Zoo education programs. Tickets are $20 for FONZ members and $28 for nonmembers.

National ZooFari

May 18—6:30 to 10 p.m.

Sample gourmet food from D.C.-area restaurants and fine wine from around the country, and dance the night away at this year's ZooFari. The theme, "Black & White Night," celebrates the Zoo's giant pandas, Tai Shan, Mei Xiang, and Tian Tian, and proceeds from the event will help the National Zoo conserve giant pandas in zoos and in the wild. Tickets are $110 for FONZ members and $140 for nonmembers.

Zoo Morning

June 17—7:30 to 10 a.m.

At FONZ's free member appreciation event, see how the Zoo prepares for the day. Bring your membership card for admittance.

Sunset Serenades

Thursdays, June 29 to August 3—6:30 to 8 p.m.

Sponsored by Starbucks Coffee Company, WARW Radio, and Yellow Book.

Enjoy six evenings of free musical entertainment on the lawn of the Zoo's Lion/Tiger Hill. With a range of musical styles including oldies, jazz, pop, rock, blues, and classical, these concerts are sure to please people of all ages.

Tai Shan's Birthday

July 9

Celebrate the first birthday of the Zoo's giant panda cub with fun activities including keeper talks, crafts, a huge birthday cake, and some surprises.

Jessie Cohen/NZP

Lectures

Art and Anatomy

May 25—Lecture at 7:30 p.m.

Sculptor Antoine-Louis Barye was famous for his series of bronze animal works: cats, dogs, and horses, as well as "elephant crushing a tiger," "python swallowing a doe," and "Arab horseman killing a lion." The Zoo's Theodore Grand, one of the world's foremost comparative anatomists, will discuss the accuracy of Barye's work in terms of body proportions, musculoskeletal anatomy, and biomechanics, and also trace its basis to Greco-Roman medical science and art. For more information or to RSVP, visit **www.fonz.org/lectures.htm**.

Call to Nominations

In accordance with our Bylaws, the Friends of the National Zoo Board of Directors is now soliciting nominations from the membership. Our volunteer Board plays an essential role in FONZ leadership and operation, and we rely on our members to recommend people with appropriate skills and talents to assist our efforts to support the Smithsonian's National Zoological Park.

I ask you to help by nominating to the Board persons who are interested in this very special community service. Nominations will be reviewed by the Board's Nominating Committee. The names of selected candidates will be forwarded to the membership for election. The criteria by which potential candidates are judged for nomination to the Board of Directors include: the candidate's strong interest in supporting zoological education, research, and conservation in accordance with the purposes of our corporation; leadership; experience or skills that are needed and that would directly benefit FONZ management and operations; and the willingness to commit significant amounts of time to participate fully in FONZ work and activities. Candidates must be dues-paying members of FONZ.

Much of the Board's work is accomplished through committees. For example: The Education Committee makes policies and provides guidance for FONZ-supported education, conservation, and outreach programs. The Membership Committee develops policies related to membership activities and provides oversight for membership acquisition and retention programs and fundraising for the Zoo. The Guest Services/Concessions Committee formulates policies for FONZ concessions operations and visitor support services. Other Board committees include: Development, Nominating, Events, and Finance and Audit.

All Board members are expected to serve on committees and may be asked to attend one or more meetings or functions each month. Nominations may be made only by dues-paying members and must be submitted on an official FONZ Nomination Form with a biography of the nominee. Call 202.633.3074 to receive nomination forms or to discuss Board services with me or a member of the Board. The deadline for submitting nominations is May 31, 2006.

James M. Schroeder
Executive Director, FONZ

ZooFari Sponsors

FONZ would like to thank the following sponsors for supporting ZooFari.

GEICO geico.com

NEWS TALK 630 WMAL

AmericanAirlines

The New MIX 107.3 The Best MIX of... Everything

Comcast

NBC 4 nbc4.com

FUJIFILM

EU SERVICES
A full color, full service printing & mailing company
Specializing in customized direct mail communications

Washington Mystics

Smooth Jazz 105.9

Coca-Cola Classic

CHEVY CHASE® BANK

Many animals vocalize, and some sing, but only a select group of birds, including this prothonotary warbler (*Protonotaria citrea*), as well as some whales and possibly bats and mice, learn to sing.

Robert Royse

Singing Lessons

BY MARY-RUSSELL ROBERSON

Everyone knows that birds sing. Many people know that some species of whales sing. But did you know that bats and mice sing? Or that some animals produce songs by instinct, while others learn their songs from their parents? Biologists, neurobiologists, psychiatrists, speech therapists, and others are delving into the secrets of learned singing. What they are discovering is illuminating the workings of the brains of birds and humans, and may eventually lead to new treatments for human speech disorders and learning disabilities.

WHAT IS SONG?

In the animal world, a song is a specific type of vocalization. Many animals vocalize in one way or another, by grunting, snorting, or barking, for example. Some vocalizations have a communication function: Alarm calls alert others to the presence of a predator, agonistic calls communicate aggression, begging calls solicit food from parents, and mating calls advertise availability. Songs are also used for communication, but typically are much more elaborate than calls. The difference between a song and a call, while fairly easy to recognize intuitively, is difficult to explain, perhaps because "song" is such a well-worn word in everyday English. When asked to define song, scientists who study it usually give a disclaimer first. Richard Mooney, a neurobiologist at Duke University Medical Center, who studies how birds learn and produce song, says, "Song is a loaded word. It has many meanings to humans and most of those relate to special human behaviors." And Timothy Holy, assistant professor of neurobiology at Washington University in St. Louis, says, "I don't think there is a single definition that everyone subscribes to."

Those caveats notwithstanding, most scientists agree that a song is longer and more complex than a call, and has a melodic and rhythmic structure, often involving repeated patterns over both short time periods (tens of milliseconds) and longer time periods (seconds). Songs typically also include more variation in frequency (pitch) and intensity (volume) than calls do. Call and song are really two ends of a continuum, and different people draw the dividing line at different places.

A chick's peep, a wolf's howl, and a lion's roar are all calls. The white-throated sparrow's (*Zonotrichia albicollis*) "Old Sam Peabody, Peabody, Peabody," a pre-dawn gibbon (*Hylobates* spp.) duet, and a humpback whale's (*Megaptera novaeangliae*) haunting melody are all songs. A chorus of spring peepers (*Pseudacris crucifer*) could be considered either. And a pig's grunt is just a vocalization.

In most cases, the function of song relates to territory, breeding, or social cohesiveness. In temperate climates, male songbirds sing to defend their territories and announce their interest in mating. Numerous studies using real birds and tape-recorded songs have shown that the sound of a male songbird singing repels other males of that species, and attracts females that are ready to breed. "If you render a male incapable of singing, he loses his territory and he loses his mate," Mooney says.

In most cases, the function of song relates to territory, breeding, or social cohesiveness.

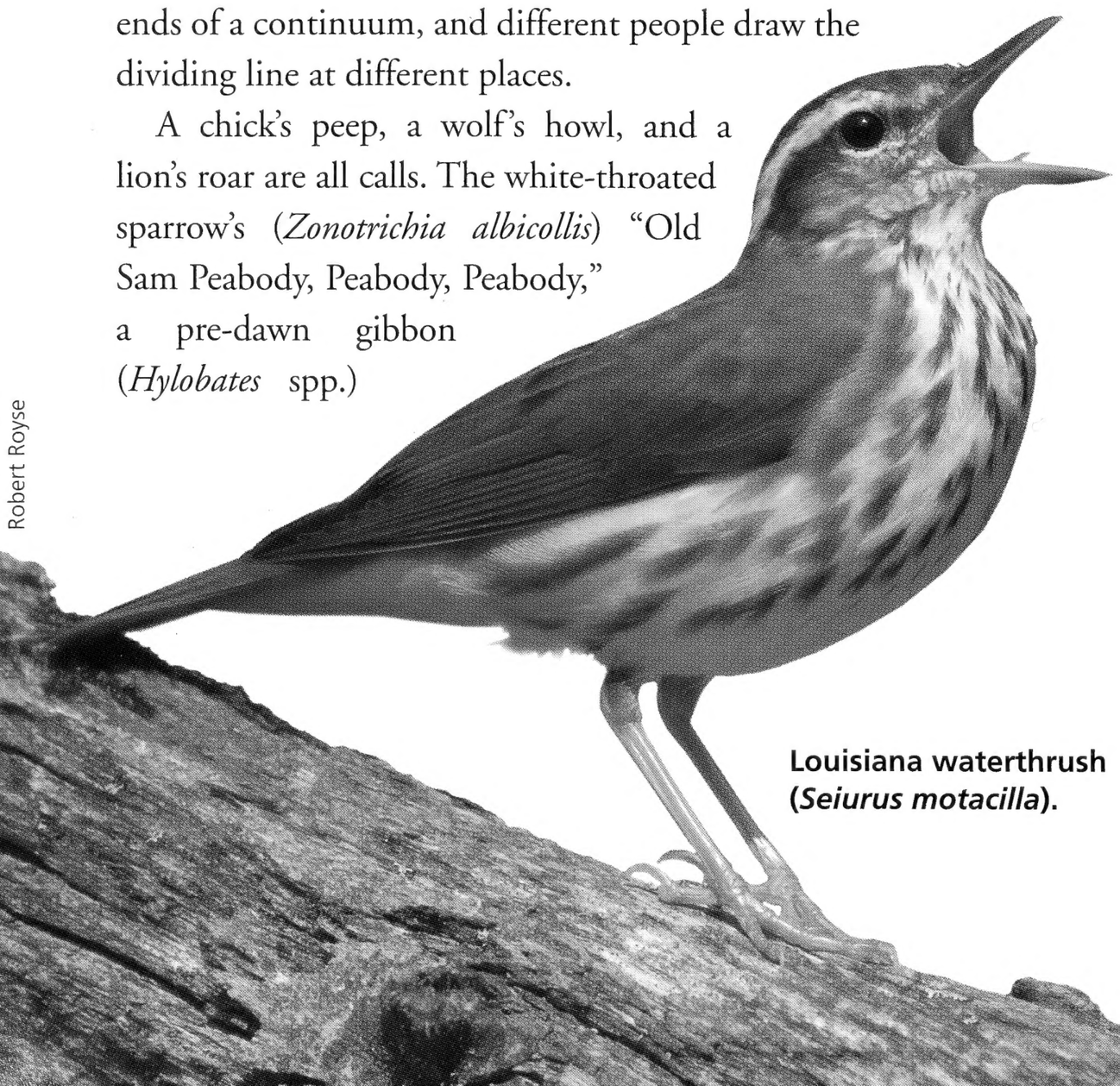
Birdsong functions a little differently for birds that live in the tropics year-round, according to Eugene Morton, senior scientist emeritus at the Smithsonian National Zoo's Center for Research and Conservation and coauthor of the 1992 book *Animal Talk: Science and the Voices of Nature*. For these tropical birds, singing is more about defending territory and less about breeding, and females and males sing year-round. Morton also points out the evolutionary advantage of singing: "The real use of these songs is to be able to defend a territory without having to patrol" its perimeter on the wing. Flying uses a lot of energy, so it is in the best interests of birds to minimize flying time.

Innate and Learned Songs

Most animal singers perform innate songs, but a select few learn their songs from their parents and other adults. "There are animals that vocalize, and a subset of those sing, and a very small subset of those learn to sing," Mooney says.

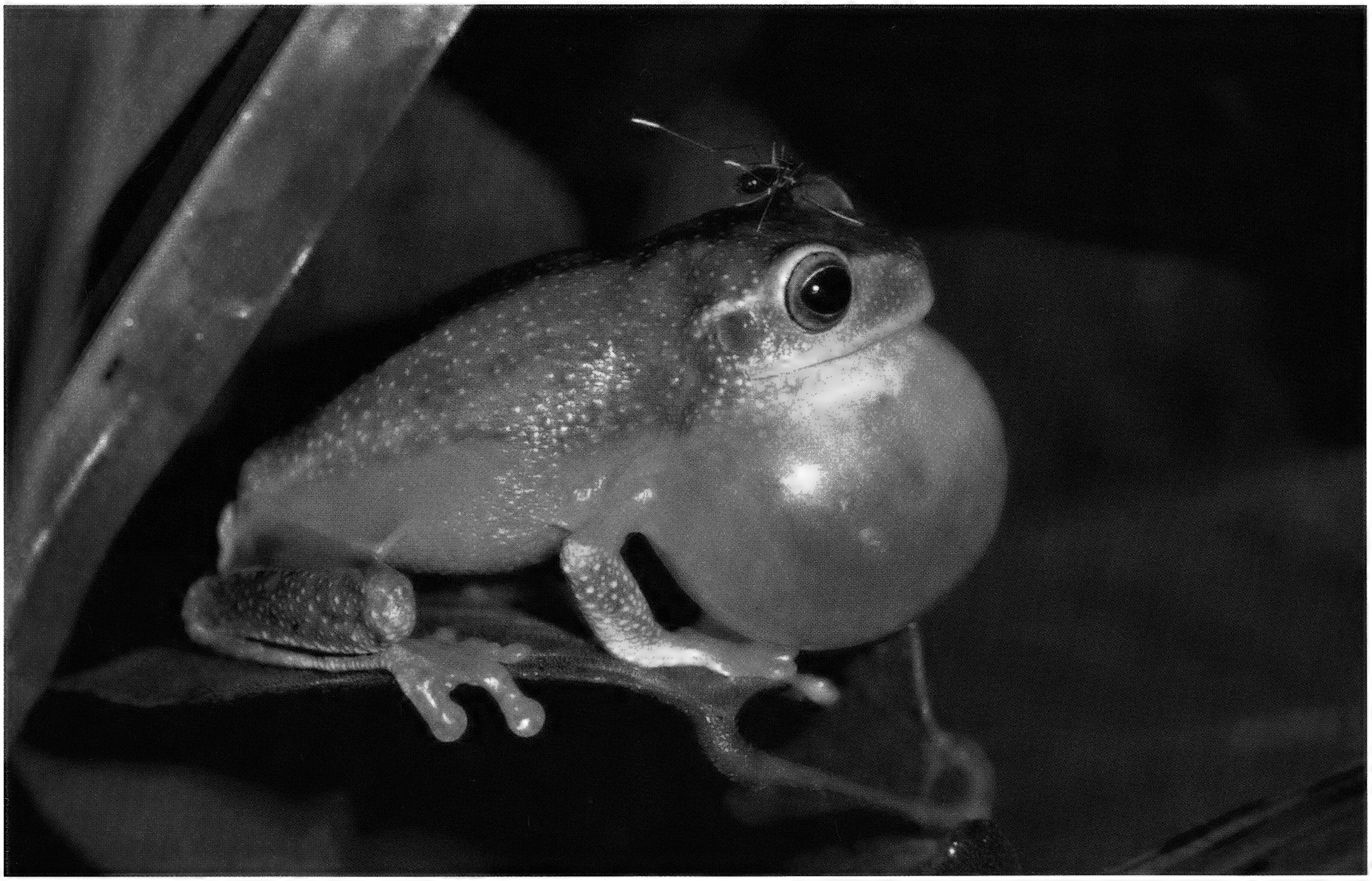
While many birds sing, only parrots, some hummingbirds, and true songbirds (members of the Oscine suborder of Passeriformes, which includes warblers, finches, sparrows, and thrushes) learn to sing, by listening to adult members of their own species. Any oscine bird raised in isolation will sing as an adult, but its song will be strange and highly simplified. Birds that do not learn to sing, such as phoebes (*Sayornis* spp.), sing the same songs as adults whether raised normally or in isolation from other phoebes.

Several frog species sing. Male concave-eared torrent frogs (*Amolops tormotus*) from the Huangshan Hot Springs region of China produce tonal vocalizations that sound like bird songs, including "warbles," which are rapid up-and-down changes in frequency. The frogs have a vast repertoire—in 12 hours of recordings of 21 males, the researchers found no identical songs. Interestingly, even though these frogs' songs are audible to humans, they also contain ultrasonic



Robert Royse

Louisiana waterthrush (*Seiurus motacilla*).



Bruce Coleman Inc./Michael Fogden

A male dainty green tree frog (*Litoria gracilenta*) inflates his vocal sac to produce a raspy mating call. While most frog species call, some, such as the concave-eared torrent frog, sing complex songs that resemble birds' warbles.

harmonics, which other frogs can hear over the ambient noise of fast-rushing streams. Scientists are conducting research to determine whether these songs are learned or innate.

Among mammals, some whales, and perhaps bats and mice, learn to sing. "There's no evidence for vocal learning in other groups," Mooney says, "although we haven't studied everything that's out there." Human speech is a learned vocalization, but it has some attributes that put it into a class of its own.

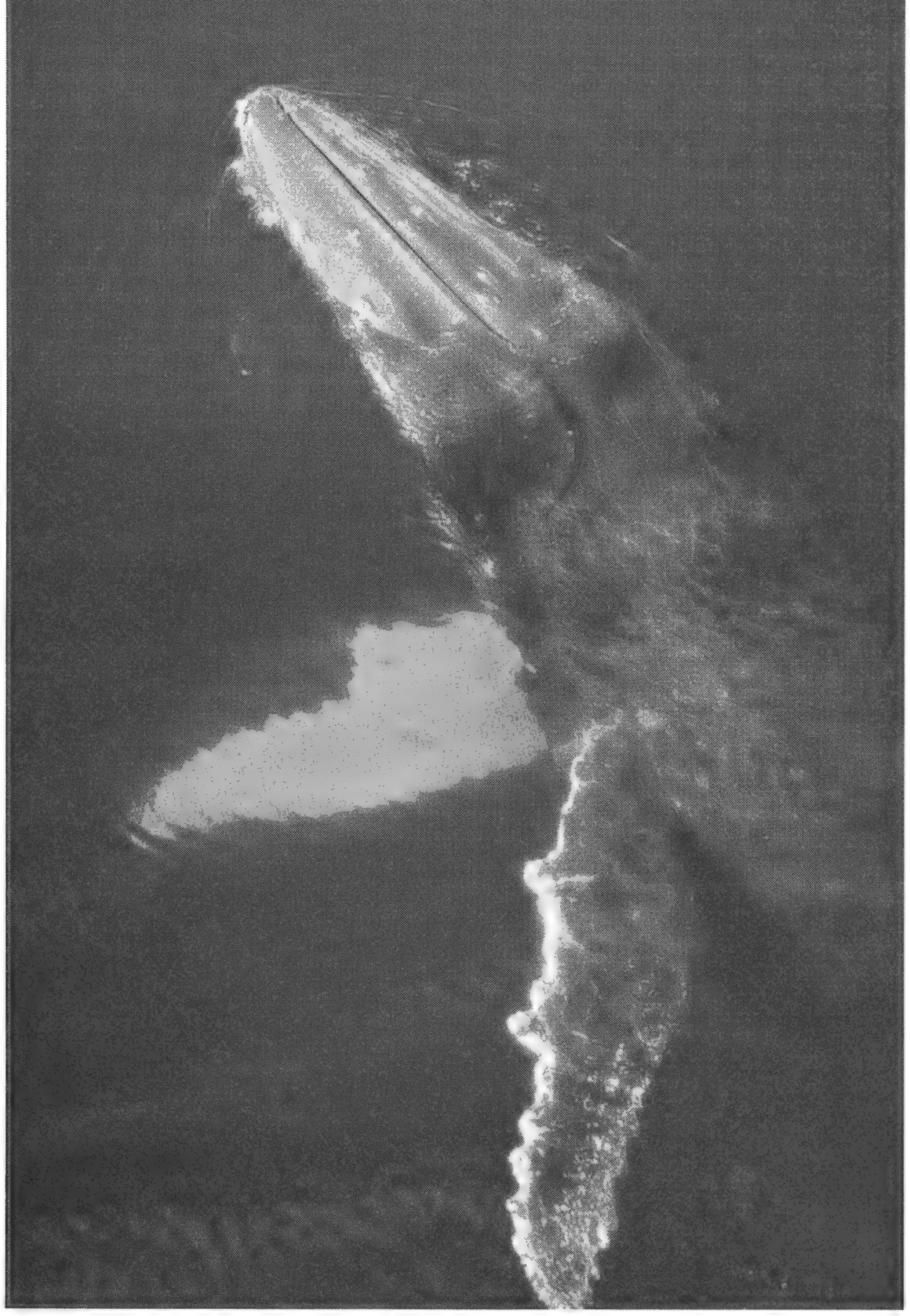
No one has yet found any evidence for learned vocalization in nonhuman primates. About 25 species of primates in four genera sing, but their songs are innate: A macaque (*Macaca* spp.) raised by a different species of monkey makes macaque sounds when it grows up, for example. Gibbons produce loud and long songs, usually duets performed by mates. These apes, which live in the rainforests of Southeast Asia, sing in ten- to 30-minute bouts near dawn. Males and females sing different parts, alternating in a modified call-and-response structure. Although complex, these songs are not learned. A hybrid female gibbon born in a zoo inevitably sings something resembling a mixture of the female songs of her parents' species. This is true even if she never hears the female song of her father's species and hears only the female song of her mother's species.

Mammals That Sing

In the 1960s and '70s, scientists discovered that male humpback whales produce very low-pitched, complex songs with patterns and structure. "Humpback whale songs are very much like birdsong," says Salvatore Cerchio, a scientist at the Wildlife Conservation Society. For example, their song structure, called eventual variety, is also found in some birdsong: They repeat phrase A several times, then phrase B several times, then phrase C several times, and so on, then start over with A. Whales also sing for reasons similar to birds'. "We know it's a male breeding display," Cerchio says. "What's not clear is whether the song is a signal directed at males or females or both. It's currently under study and debate."

> The frogs have a vast repertoire—in 12 hours of recordings of 21 males, the researchers found no identical songs.

Most scientists believe that humpbacks learn their songs, because individual whales sing slightly different versions. However, Cerchio wonders if there are some innate aspects. "Humpback whales are quite unusual in that their songs show rapid change over time," he says. "All males in a given population sing a very similar song at any one time and they all make the same subtle, gradual changes to it over the course of the season." He and some of his colleagues studied the songs of two humpback whale populations during the breeding season (late winter and early spring) of 1991. Although the two populations were separated by more than



Gerald and Buff Corsi/California Academy of Sciences

Even when separated by great distances, humpback populations make similar changes to their songs during breeding season.

3,000 miles, the songs of both groups changed in a similar way over the course of a few months. There is no evidence that whales swim back and forth between the two areas, and even if they did, it would take about 40 days to swim from one to the other. For these reasons, Cerchio believes something more than cultural transmission might be going on. He suggests that there may be some innate rules that govern the way songs are changed.

Some other baleen whales sing, including bowhead (*Balaena mysticetus*), fin (*Balaenoptera physalus*), and blue whales (*Balaenoptera musculus*). However, none produces songs as complex as humpbacks'. "It's very possible that other species of baleen whale have some songlike vocalizations; we just don't have enough information yet," says Cerchio.

Toothed whales, including dolphins, killer whales, and sperm whales, do not seem to make songlike vocalizations at all, says Cerchio, but they do produce a wide variety of other vocalizations, such as clicks, calls, and whistles. They also echolocate, meaning they analyze echoes from their vocalizations to perceive the position, shape, and velocity of nearby objects.

Bats, which also echolocate, have at least some singers in their midst. Scientists have recently recorded and analyzed the previously unknown courtship songs of the sac-winged bat (*Saccopteryx bilineata*) of Costa Rica. For the most part, the songs are too high-pitched for humans to hear, which is probably why they were not discovered earlier. Male sac-winged bats typically sing while hovering in front of a female or moving fitfully on a nearby perch. The songs vary from bat to bat, but whether sac-winged bats learn their songs, and whether other bat species sing, remains to be seen.

Toothed whales, including dolphins, killer whales, and sperm whales, do not seem to make songlike vocalizations at all, but they do produce a wide variety of other vocalizations, such as clicks, calls, and whistles.

Lab mice produce ultrasonic songs, too, as Washington University's Timothy Holy recently discovered by accident. Holy studies the neurobiology of the olfactory system, and wanted to identify behaviors in male lab mice that signal the presence of female pheromones. Male mice sometimes produce ultrasonic vocalizations when they smell females, and Holy thought those vocalizations might be reliable "pheromone indicators." To test this theory, he and colleague Zhongsheng Guo placed male mice in sound chambers with cotton swabs soaked in mouse urine and recorded the sounds the mice produced.

Other scientists have studied mouse vocalizations, but never recorded as much acoustical detail or scrutinized the results as thoroughly as Holy and Guo, who used a sophisticated microphone and a computer to help identify different sounds and patterns. "Also, I wrote software to switch [the vocalizations] into a range we could hear, so we could listen to them," Holy says. "They were much more interesting than I expected them to be."

When Holy analyzed the sounds of 45 male mice, he discovered vocalizations with enough complexity and pattern to rival the songs of some birds. He identified three basic types of sound components, or pitch jumps, that when combined make several different recognizable "syllables." The presence of the syllables and the fact that they tended to occur in particular sequences led him to characterize the vocalizations as songs.

Holy's research was published in the journal *PLoS Biology* in December 2005 and has generated intense interest among scientists. What function do the songs serve? Do female mice sing? Do different genetic strains of lab mice sing different songs? Do wild mice have a wider repertoire than lab mice? The most frequently asked question is whether mice learn songs. Holy's finding that an individual mouse's songs were more similar to each other than to songs of other, genetically identical mice suggests that their songs are learned rather

than innate. Holy says, "We are not going to be [looking into that question] ourselves...but we have friends who seem to be looking into it."

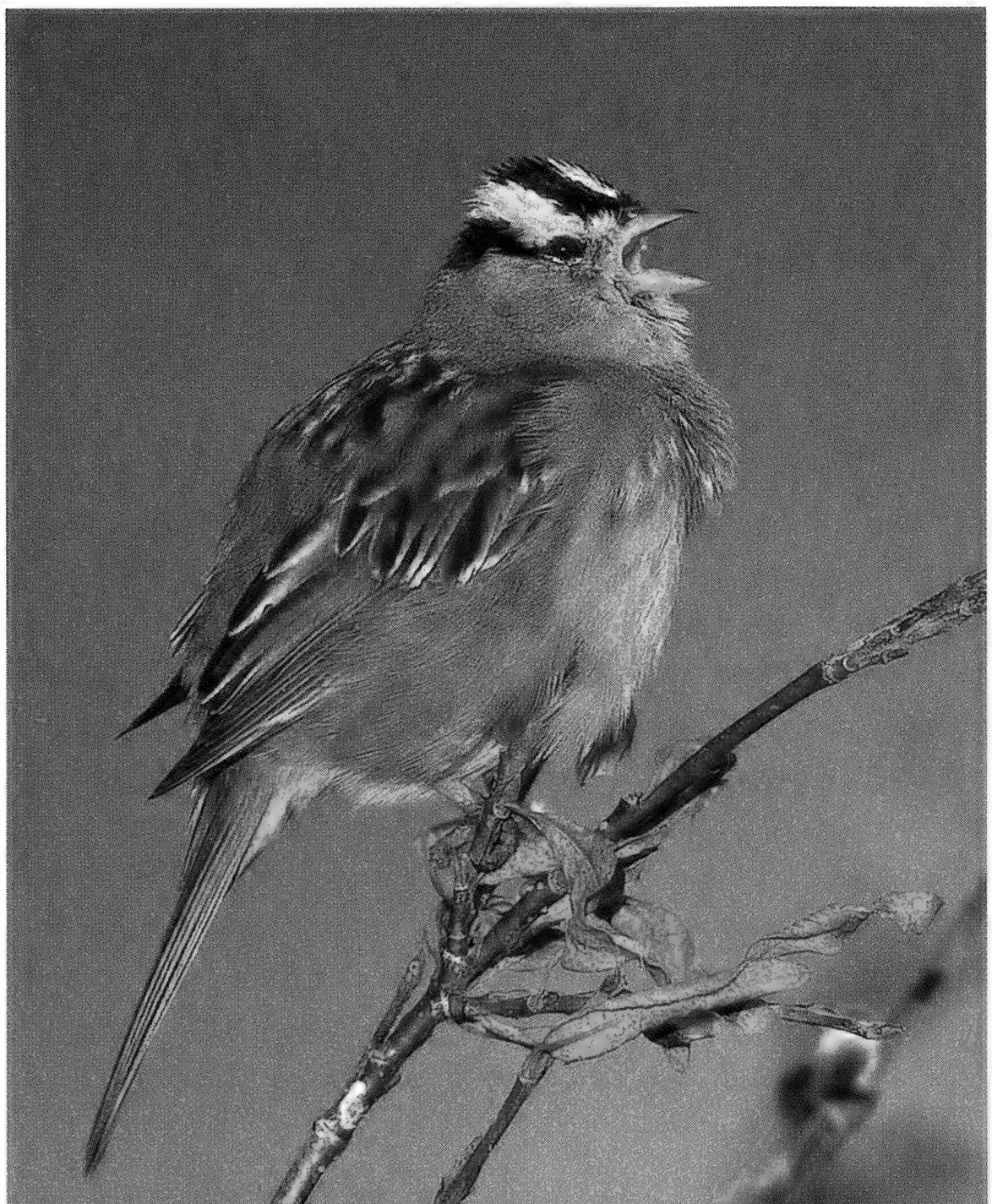
How Do Birds Learn to Sing?

Scientists know far more about singing birds than any other singing animals. Whales are difficult to study because of their size and habitat, and of course they can't be brought into a lab. Bats rarely display behavior related to territory or courtship when in captivity, and their songs, like those of mice, have only recently been discovered.

Songbirds have been studied in the field for hundreds of years and in the lab for decades. Scientists are still investigating how and why birds learn to sing.

For example, recent studies of zebra finches (*Taeniopygia guttata*) and European starlings (*Sturnus vulgaris*) illuminate another function of birdsong: Females can evaluate a male's past by listening to his song. Males that experienced an unusual amount of hunger or stress when young produce less complex songs than other males as adults, which puts them at a disadvantage because females seem to prefer males that sing complex songs.

Neurobiologists have uncovered striking differences in the brains of birds that learn to sing and those that don't. "There's a very extensive and well-defined neural circuit in the songbird's brain that ultimately forms connections with the motor neurons used in singing,"



Robert Royse

William Osborn/www.naturepl.com

Female zebra finches evaluate the songs of potential mates.

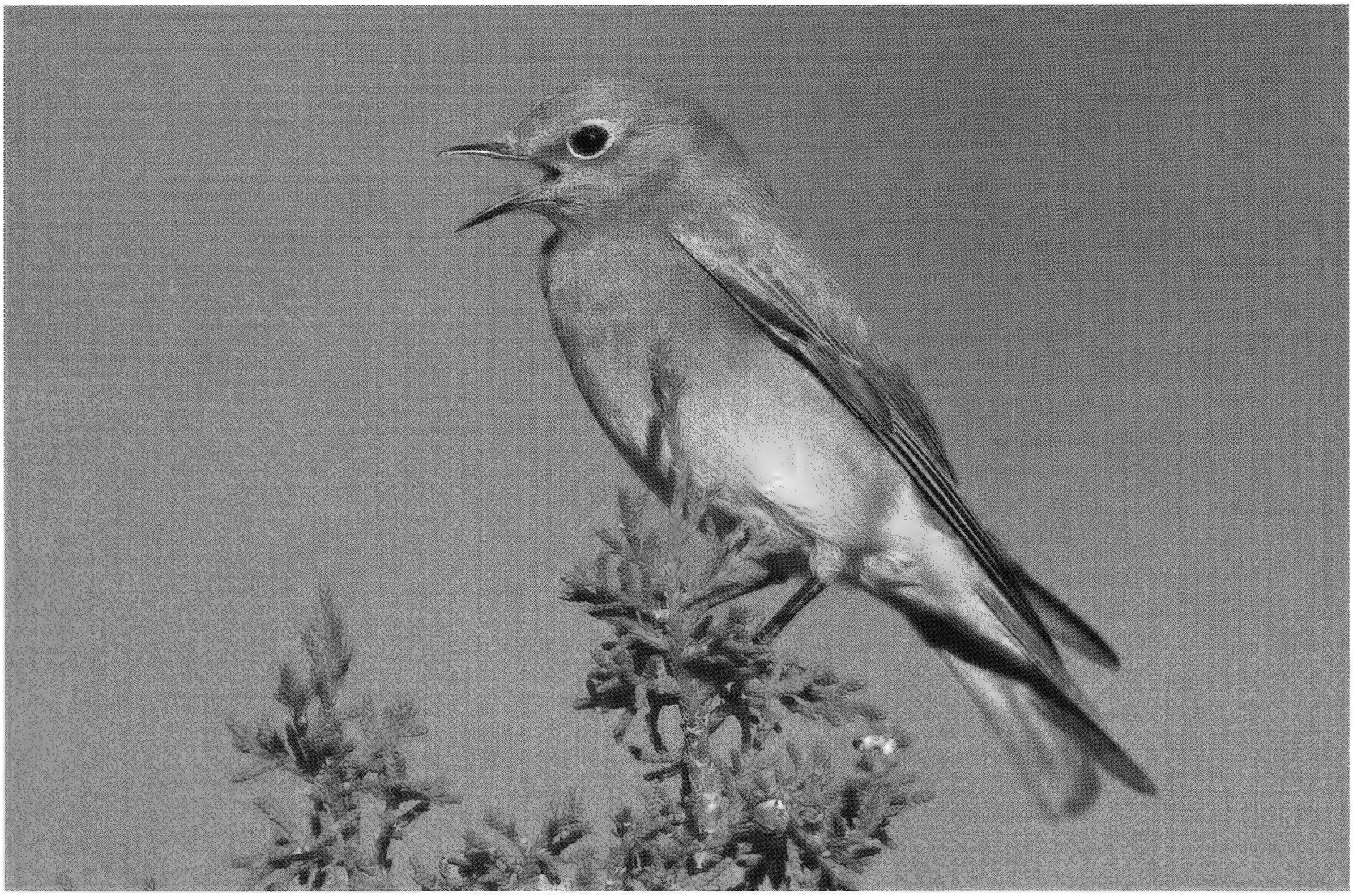
Mooney says. "The circuitry is well developed in birds that learn to sing and absent in nonlearners. In species where the males sing and the females don't, these special song structures are really big in the male and really small or almost absent in the female."

Baby songbirds learn their songs by mimicking adults. If a baby songbird is isolated from its parents and exposed to unrelated birds of the same species, birds of other species, or tape recordings, it will learn the songs that it heard rather than those of its biological parents. And in species that learn to sing, birds that are born deaf or raised in isolation will not sing normal songs.

Laboratory studies with birds, mostly zebra finches and white-crowned sparrows (*Zonotrichia leucophrys*), have demonstrated that learning to sing takes place in two phases: In the first step, young songbirds listen to and memorize the songs of an adult (called a tutor), and in the second step, the young begin to vocalize these memorized songs, refining them through practice. In many species there is an interval of time between these two phases, because the adult males leave or stop singing before the young begin to practice. Eight months separate the two phases for swamp sparrows (*Melospiza georgiana*), indicating they have a prodigious memory. In other songbirds, such as zebra finches, the two phases overlap by about a month.

It's obvious that hearing is necessary for the first, listening phase. But hearing is just as critical for the vocal practice phase. That's because the bird must hear itself, compare its sound to that of the

White-crowned sparrows learn to sing in two phases.



Robert Royse

Oscine birds such as this mountain bluebird (*Sialia currucoides*) learn to sing in a process similar to the way human babies learn to speak. First, the birds listen to and memorize adult songs, then practice singing what they've heard.

adult, and make precise adjustments to more closely match the tutor. Learning to sing depends on this complex auditory feedback system. Birds that can hear in the first phase but are deaf in the second phase will sing abnormal songs.

Young birds learn to sing with little apparent effort, but after sexual maturity, most are no longer able to learn new songs. (A few birds, including canaries and starlings, can learn new songs into adulthood; they are called open learners.) The period of time during which birds can memorize new songs is called the critical or sensitive period. For example, white-crowned sparrows memorize songs easily between 20 and 50 days of age, and then gradually lose this ability. After about 100 or 150 days, most can no longer learn new songs. Scientists are investigating what signals the critical period to close; possibilities include hormones, quality of sensory experience, and social factors.

Ayako Yamaguchi, an assistant professor of biology at Boston University, discovered that the sensitive period closes at drastically different times in male and female northern cardinals (*Cardinalis cardinalis*), one of the few species that live in temperate regions of North America in which both males and females sing. Cardinals are actually tropical birds that have expanded their range northward in the last 100 years, probably due to the presence of bird feeders.

The sensitive phase for cardinals begins when they are between ten and 20 days old. "Males continue to memorize until they reach seven, eight, or nine months of age while females are done by three months of age," Yamaguchi says. She speculates that males may need a longer sensitive period because, as they mature and disperse, they must match their songs to those of males already living in their new territories in order to fit in and successfully establish their own territories. Yamaguchi's research suggests that male and female cardinals' brains function differently even though they are raised in the same environment.

> Humans, like birds, have a critical period in childhood in which learning language is nearly effortless.

Song and Speech

The process by which birds learn to sing is remarkably similar to how human babies learn to speak. Babies learn speech from their parents and others around them, just as birds learn birdsong. A Japanese baby raised in an English-speaking environment learns to speak English, not Japanese. Deaf babies do not spontaneously produce spoken language, but will usually learn sign language if they are exposed to it.

Human babies also go through listening and practicing phases, but without the interval between them that some birds experience. Hearing is essential in both phases, just as in songbirds. When children become deaf during the second, practicing phase, they do not

learn to speak normally without extensive coaching; if they were already talking when they became deaf, their speech often deteriorates rapidly. People who become deaf as adults (that is, after the second phase), are usually able to maintain fairly normal-sounding speech.

Humans, like birds, have a critical period in childhood in which learning language is nearly effortless. Adults can learn foreign languages, but speak with an accent, and have more difficulty with grammar and comprehension than children learning a second language.

If human speech is analogous to birdsong, what is human song? Is it just another form of speech? Mooney says no: "Although allied with speech, it's something else. The human capacity for music is really an unusual trait."

Human brains process speech and music differently. Someone listening to music with or without lyrics typically shows more activity in the right side of the brain, while someone listening to speech typically shows more activity in the left side of the brain. Human music also sounds different from animal song—it has a stronger rhythmic component (a steady beat) and is less stereotypic, allowing for improvisation within some basic rules of melody and rhythm. Songs composed by two different humans, say Mozart and Janis Joplin, sound much less alike than the songs of two different white-crowned sparrows.

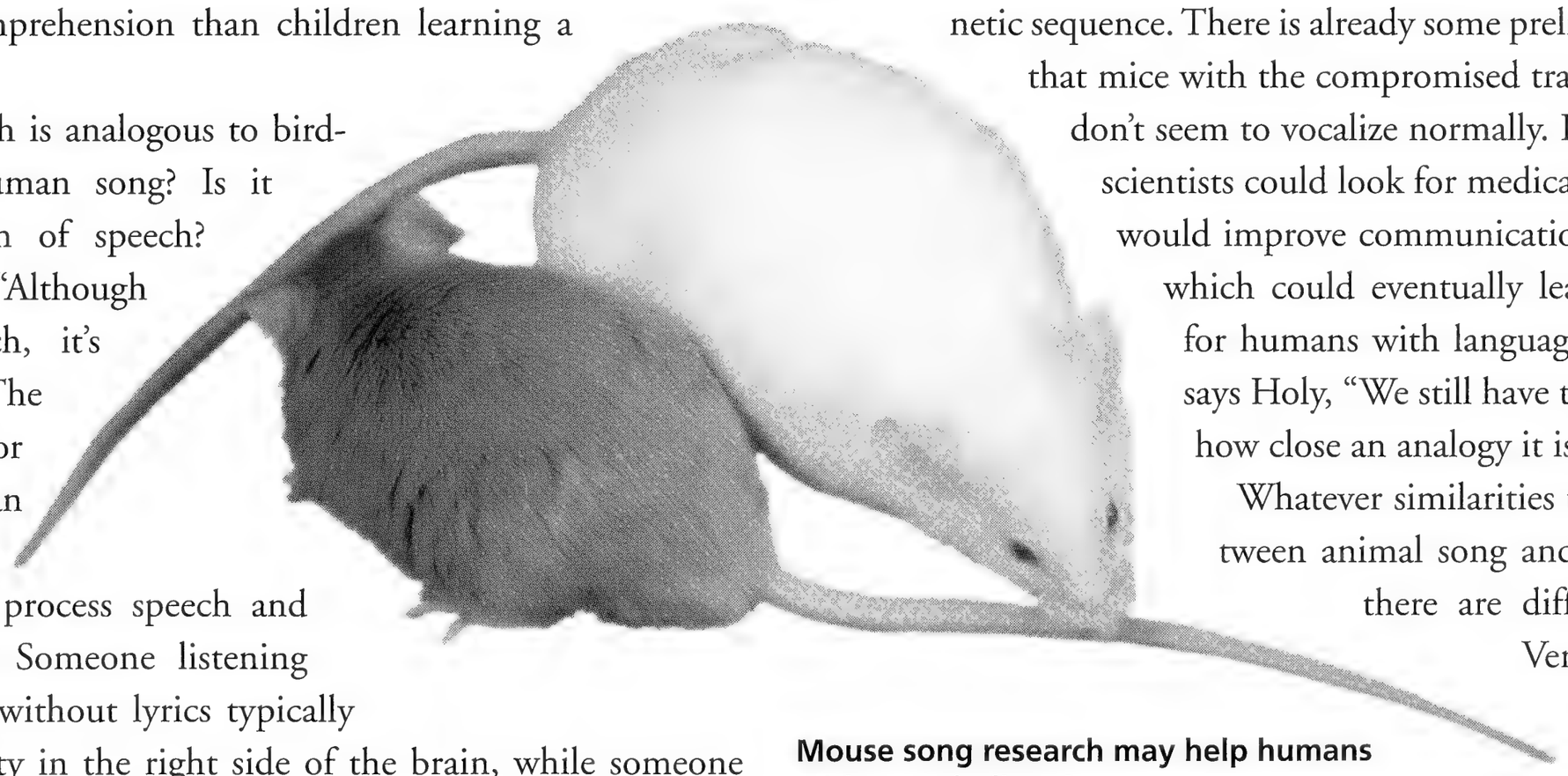
Medical Implications of Song Research

The similarities between birdsong and speech are fueling research that one day could lead to better treatments for speech disorders. For example, finding the triggers that close the critical period in birds could lead to figuring out how to extend or "re-open" the critical period in humans. Such a discovery might make it possible to improve speech skills in people with dyslexia, autism, hearing impairments, and people who have suffered a stroke or brain injury.

Mice, being mammals, are potentially even more analogous to humans. Furthermore, scientists have a fairly complete map of the mouse genome. "The mouse could be an interesting organism for studying more about vocal production and communicating," Holy explains, "because mice, more so than birds, are suited to studies in which genes are being controlled and manipulated. It would give an extra set of tools to scientists who are interested in how brains produce the commands that make sounds."

One promising topic for research in mice is a genetic sequence called the Foxp2 transcription factor, which, according to several studies, turns on when a bird sings. "We don't know what its specific role in the song is: It may be it's important to generate the motor movements or it might be something more high-level in the brain," says Holy. In certain human families that have a high prevalence of speech disorders, scientists have found a mutation in the Foxp2 genetic sequence. There is already some preliminary evidence that mice with the compromised transcription factor don't seem to vocalize normally. If this is the case, scientists could look for medical treatments that would improve communication in these mice, which could eventually lead to treatments for humans with language disorders. But, says Holy, "We still have to be cautious for how close an analogy it is."

Whatever similarities there may be between animal song and human speech, there are differences as well. Vertebrate brains have evolved to process two different types of sound—animal vocalizations, and environmental sounds such as snapping twigs, which may signal the approach of a predator. Animal vocalizations tend to be more harmonic and to occur in a more narrow frequency range than environmental sounds. Michael Lewicki of Carnegie Mellon University in Pittsburgh has made mathematical models that show the relationship between incoming sound and the activity in the mammalian auditory nerve. The model for animal vocalizations looks different than the model for environmental sounds. When Lewicki calculated the model for human speech sounds, it fell in between animal vocalizations and environmental sounds. This suggests that as human speech evolved, it made efficient use of the brain's pre-existing ability to process both types of sound.



Bruce Coleman Inc./C. C. Lockwood

Mouse song research may help humans with speech disorders.

The most obvious gulf between the two is that animal song, unlike human language, has no semantic content. When animals sing, they may be communicating something about their territory or their availability for mating, but they cannot say something as complicated as, "Last week I saw five rhinoceroses—four adults and one baby—drinking at the medium-size creek that empties into the river north of here."

Nevertheless, as countless scientists are demonstrating, humans stand to learn much from studying how animals learn to sing. Z

—Mary-Russell Roberson is a science writer living in Durham, North Carolina.


Frans Lanting/www.lanting.com

It's Elementary

BY SUSAN LUMPKIN

The plot could come straight from a casebook from TV's *CSI*. Two men are the prime suspects in the murder of their mother. DNA from a single hair left at the scene of the crime ties them to the matricide, but which brother did it? The men happen to be identical twins, so their DNA is identical too, and neither brother is talking. Then the diligent *CSI* team uncovers a crucial difference between them: Brother A is religiously vegan, while Brother B abhors greens and eats only meat. Running the precious hair through a handy mass spectrometer, a device that measures stable isotopes, reveals the killer is a carnivore. Case closed.

Sound far-fetched? Although this case is pure invention, it's not implausible. In the past ten years, scientists have learned a lot about how measuring stable isotopes in tissues such as hair, feathers, and blood provides insights into an animal's diet and its place in the food chain. And scientists are applying this knowledge to solve a wide array of problems, from determining whether Neanderthals were scavenging or hunting carnivores, to tracking crop-raiding African elephants, and, yes, telling whether a person is a vegan or not.

Scientists at the Smithsonian Migratory Bird Center (SMBC) at the National Zoo are using stable-isotope analysis to follow the routes of migratory birds between northern breeding grounds and southern wintering areas. As a result, they are making remarkable advances in understanding how birds' ecology and behavior during one part of the year influences those during other times—and providing crucial information for migratory bird conservation.

Stable isotopes demonstrate the truth of the old adage, "you are what you eat."

Geraid and Buff Corsi/California Academy of Sciences

Stable isotopes are forms of an element that work identically in chemical reactions but differ in mass because they have different numbers of neutrons in the atoms that make up the element. For instance, there are two stable isotopes of carbon, referred to as ^{13}C and ^{12}C; ^{13}C has one more neutron than ^{12}C. Nitrogen also has two stable isotopes, called ^{15}N and ^{14}N. For reasons explained later, these are the stable isotopes, along with those of hydrogen and oxygen, most commonly measured by ecologists. Because the stable isotopes of a particular element differ in mass, it is possible to separate and measure their relative amounts in a sample. This is what a mass spectrometer does.

Turning from chemistry to biology, plants use one of three different methods, or pathways, to convert carbon dioxide to carbohydrates during photosynthesis. Depending on which of these the plants use, the relative amounts of stable carbon isotopes in their tissues differ. Plants that use what is called the C_4 pathway are primarily grasses and have a carbon-isotope signature distinct from plants that use the C_3 pathway, which are mostly trees and

shrubs. The third, or CAM, pathway is used primarily by desert plants such as cacti. Further, but for other reasons, marine plants have their own carbon-isotope signature distinct from terrestrial plants.

Now here's where this starts to get interesting. Carbon-isotope signatures are passed up the food chain, so that, for example, a grazing animal that eats grasses will have the terrestrial C_4 plant carbon-isotope signature in its tissues, while a browser that eats shrub and tree parts will have the C_3 signature. The carbon-isotope signature of an animal that eats a mixed plant diet will be intermediate. Further, carnivores—both meat and insect eaters—have carbon-isotope signatures that match those of their prey.

Nitrogen-isotope signatures are revealing too, but in a different way. The heavier isotope, ^{15}N, increases as you go up a food chain. Carnivores have a higher ratio of ^{15}N than herbivores, and herbivores have a higher ratio than the plants they eat. (Omnivores that eat both meat and plants, surprisingly, have the lowest ^{15}N ratios, rather than being intermediate between carnivores and herbivores.) So, to go back to our *CSI* case, the higher ^{15}N in the evidentiary hair nailed the murderous meat-eating twin.

In a scientific study published in 1999 in the *American Journal of Physical Anthropology*, T.C. O'Connell and R.E.M. Hedges of Oxford University looked at the nitrogen-isotope signatures in hair samples from people who were vegans, ovo-lacto-vegetarians, and typical omnivores (people are rarely strict carnivores like the hypothetical Brother B). They found a significant difference between the vegans and the other two groups, but not between omnivores and ovo-lacto-vegetarians, because the latter do not eat meat but do eat animal products—milk and eggs—which have the same isotope signatures as beef and chicken.

Scientists have also identified other predictable relationships between stable-isotope ratios and environmental variables. For instance, carbon-isotope ratios vary with latitude and between species living in open versus forested habitats. Terrestrial animals that live in dry habitats have different carbon- and nitrogen-isotope ratios than those living in moist habitats. Stable isotopes of hydrogen and oxygen vary in the rain that falls over different parts of the globe, and thus in the local water available to animals; the isotope ratios found in animal tissue are closely related to those of the local water. Hydrogen and oxygen ratios also vary with latitude, and as you move inland from coastal areas.

The information scientists can gather from measuring stable isotopes in animals has enabled them to resolve some once-intractable problems.

Hunter or Scavenger?

Stable-isotope analysis has been a godsend to anthropologists trying to understand the subsistence strategies of early humans and their relatives, including Neanderthals. Were they active hunters who got their meat from herbivores such as deer and wild cattle they killed themselves, or were they mostly skulking omnivorous scavengers who opportunistically stole the kills of other carnivores but relied on plant food most of the time? Stone and bone tools and the remains of herbivores in archeological sites clearly indicate that they hunted at least sometimes, but this is not evidence that they hunted all of the time. Moreover, the association of tools with herbivore remains could as easily be a sign of scavenging as a sign of hunting. And because plant foods decay so rapidly, they rarely appear in archeological deposits.

To get at the question of what Neanderthals ate regularly, scientists measured stable isotopes in a protein called collagen that was extracted from Neanderthal bones. Isotope ratios in collagen reflect an individual's diet over several years, while an array of butchered bones are merely evidence of a single meal. Studies of stable isotopes in Neanderthal remains from different parts of Europe demonstrate that Neanderthals were pretty strict carnivores, with isotope signatures comparable to those of the carnivores they coexisted with. This means that, like wolves and lions, Neanderthals were active hunters of meat on the hoof.

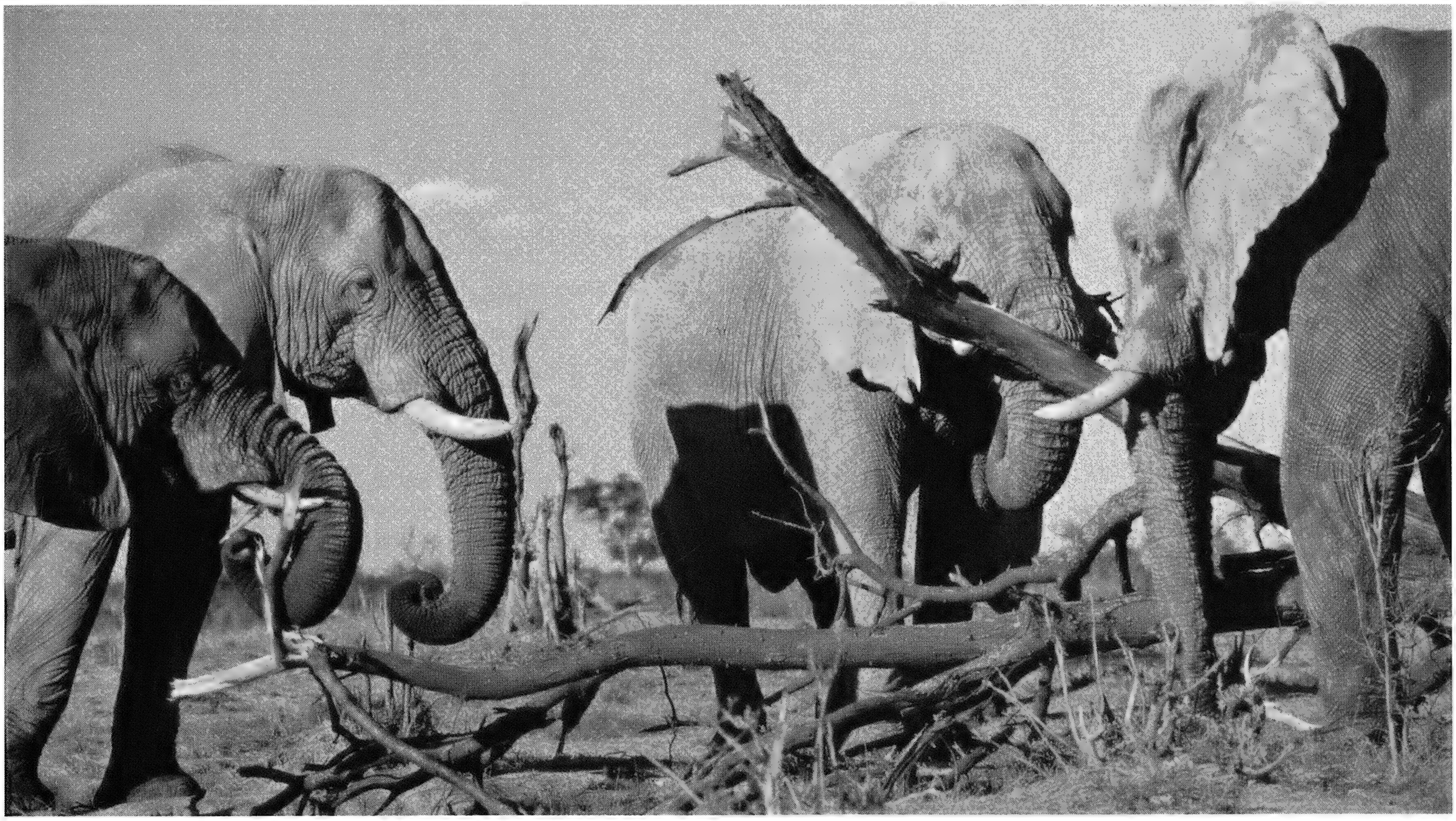
Zeroing in on Crop Raiders

The body replaces collagen slowly, so collagen's isotope ratios reflect an individual's diet over the course of several years. Hair and fur grow and are replaced rapidly, so analyzing isotope ratios along a strand of hair reveals short-term dietary changes. One woman in the 1999 Oxford study described above switched from an omnivorous to a vegan diet, and changing nitrogen-isotope ratios began to register in her hair within just a few months. She moved from the United States to England at about the same time, which was registered in a similar change in carbon isotopes—U.S. diets tend to be higher in C_4 grass plants than northern European diets because Americans consume more corn (a grass) and more meat, eggs, and dairy from corn-fed animals.

A team of scientists, led by Thure E. Cerling of the University of Utah in Salt Lake City, reported using a similar analysis of isotope ratios in hair to study elephants in a 2006 paper in the *Proceedings of the National Academy of Sciences*. The researchers collected hairs from African savanna elephants (*Loxodonta africana*) for stable-isotope analysis to see how a population

Frans Lanting/www.franslanting.com

A study of stable carbon isotopes in impalas (*Aepyceros melampus*) and other bovids reveals which plants they eat.



Frans Lanting/www.franslanting.com

African elephants primarily eat C_3 plants, including these baobob trees. Stable isotopes in their tail hairs show seasonal dietary changes and whether they raid farmers' fields on occasion to consume C_4 crop plants such as corn.

of elephants resident in Kenya's Samburu National Reserve shifted its diet and habitat seasonally. But they were more interested in how the behavior of a migratory male, an old bull that visited the park several times a year, compared with that of the resident elephants.

An elephant tail hair grows at a constant rate of about half a millimeter to just over one millimeter a day. Because each tail hair grows to a length of 500 or more millimeters (almost 20 inches), it records information about an elephant's diet and habitat changes over the course of a year or more.

Savanna elephants are primarily browsers that eat C_3 plants—trees and shrubs—most of the year. During the rainy season, however, they consume the succulent new grasses—C_4 plants—that sprout with the rain. Over the course of 18 months, isotope ratios measured in the hair of the resident elephants and the migratory bull pinpointed three periods of increased grass consumption during rainy seasons, as expected. But unlike the hair of the residents, the migratory bull's hair recorded a fourth period of grass-eating during the dry season. This was when the old bull was moving out of the forest and into the adjacent croplands to feast on corn.

The ability to identify crop-raiding elephants and predict when they might cause trouble for farmers may help to alleviate the growing conflict between people and elephants, which threatens human lives and livelihoods as well as the survival of elephants.

An elephant's tail hair records information about its diet over the course of a year or more.

Tracking Migratory Birds

Work by Russell Greenberg, head of the SMBC, and Peter Marra, also of the SMBC, provides a simple, elegant example of the value of using stable isotopes to answer a question that has long plagued those who study migratory birds: Where do you start to look when the wintering grounds of a migratory bird are unknown? Other work at the SMBC uses stable-isotope analysis to get at an equally challenging problem: If you cannot track individual birds between their summer and winter habitats, how can you determine how events in one season affect those in another?

For migratory mammals and large birds, it is possible to use radio or satellite telemetry to follow short- and long-distance movements, but the required transmitters are too heavy to be attached to small birds like sparrows and warblers. Biologists have also banded an immense number of birds in hopes of sighting the same birds again on their summer or winter grounds. But for small birds with potentially vast geographic ranges at either end of the migratory route, this is largely wishful, "looking for a needle in a haystack" thinking.

Swamp sparrows are fairly common birds that range across the northern portion of North America, from Alaska to Labrador and south through the Appalachians. They nest in freshwater wetlands and migrate to spend the winter throughout the southern United States. In 1951, however, scientists discovered an unusual subspecies, known as the coastal plain swamp sparrow (*Melospiza georgiana nigrescens*), that nests only in brackish tidal marshes in Maryland, Delaware, and New Jersey. But where birds of this subspecies wintered was a mystery; no one had ever seen one except on the nesting grounds. Yet this information is critical to protecting these birds, whose small nesting distribution and specific habitat requirements

make them vulnerable to loss of habitat and other environmental changes. Greenberg found that the subspecies is already disappearing from parts of Maryland, and estimates its total population at fewer than about 28,000 pairs.

Originally, coastal plain swamp sparrows were reported to be year-long residents of the Delmarva marshes. Over the years, Greenberg and others visited the marshes of the Chesapeake and Delaware bays in the winter months in search of the coastal plain subspecies. But they came up dry. They found lots of swamp sparrows, but none of the coastal variety. Clearly, they needed a better way to narrow down their search, so they turned to—you guessed it—stable-isotope analysis.

Swamp sparrows molt, or lose and replace feathers, twice a year. They molt all of their feathers in late summer or early fall before leaving their breeding grounds for more southerly wintering grounds. In addition, they molt only their crown feathers in late winter or early spring before leaving their wintering areas. This means that the crown feathers collected when the birds first appear in their summer habitat reflect the stable-isotope ratios of the food they eat in the winter, and thus might provide a clue to the location of their winter habitat.

In the summer of 2001, Greenberg's field team collected crown feathers from coastal plain swamp sparrows in Delaware and sent them to the Alaska Stable Isotope Facility at the University of Alaska Fairbanks for analysis. (The SMBC does not have an in-house mass spectrometer, but the scientists there lust after one of these half-a-million-dollar machines!) The carbon and nitrogen signatures suggested a coastal habitat, and the hydrogen signature—remember, hydrogen ratios vary with latitude—pointed to somewhere between North Carolina and Georgia.

The following winter, Greenberg and Marra led a team of ornithologists to scour the coast of Virginia and North and South Carolina, determined to discover the birds' winter whereabouts. Based on the carbon-isotope signatures, Greenberg bet that the sparrows would occupy habitats similar to those on the breeding grounds—the fringe of brackish marsh between the pine forest and the open marsh dominated by salt-tolerant shrubs and grasses. So this is where Greenberg started his search, in Cedar Island National Wildlife Refuge near Beaufort, North Carolina. And he won: The first bird he saw as he waded into the marsh was a coastal plain swamp sparrow.

The team then found 16 more coastal plain swamp sparrows mixed in with other swamp sparrows in North Carolina and southern Virginia, but none in South Carolina. Returning to North Carolina the following December, the team caught and banded a dozen more. These preliminary results suggest that the subspecies makes a short, 150- to 200-mile migration to escape the harsh conditions of the mid-Atlantic marshes.

Redstart Reproductive Success

American redstarts (*Setophaga ruticilla*) are small insect-eating warblers that breed in moist second-growth deciduous forests over a vast area from southeastern Alaska to Newfoundland, and southward to Utah, Louisiana, and Georgia. They winter over a huge area too, from Mexico, Central America, and the Caribbean to northern South America, where they occupy both moist forests and dry scrub habitats. These birds spend six to seven months on their tropical wintering grounds, two to three months on their breeding grounds, and another two to three months migrating between them in spring and fall.

Peter Marra has been studying redstarts for many years, in the breeding season at his study sites in New Hampshire and Ontario, and during the winter in southwestern Jamaica—but he does not study the same redstarts year-round because where the birds that breed in New Hampshire and Ontario go for the winter is unknown. With redstarts, like many migratory birds, declining, Marra is interested in identifying the factors that influence their survival and reproductive success, and thus their population numbers.

Robert Royse

Black-throated blue warbler.

Scientists know a fair amount about how various factors on summer breeding grounds, such as food abundance and predation rates, affect birds' reproductive success. They are also beginning to learn more about how the availability of habitat in winter areas may limit the overwintering survival of birds, and about how both food and habitat are related to birds' ability to survive migration. The missing link, however, has been understanding how events in one period of the birds' annual cycle affect them in the rest of the year because of the difficulty of tracking the same birds throughout the year.

Some large-scale effects that do not require studying the same birds in both winter and summer have been documented. For instance, in a study published in *Science* in 2000, the SMBC's Scott Sillett and his colleagues used long-term demographic and climate data to determine that the overwinter survival of black-throated blue warblers (*Dendroica caerulescens*) in Jamaica is low in El Niño years but high when the insects these warblers eat are more abundant in wetter La Niña years. And this effect carried over into the warblers' breeding season in New Hampshire, when fledglings were heavier, and thus more likely to survive, in La Niña years, which produced more of the caterpillars that form the bulk of their summer diet.

Marra's burning question concerned events on a finer scale. The two habitat types American redstarts occupy in winter are significantly different in quality. Moist forests, such as mangroves in Jamaica, sup-

Robert Royse

American redstart.

port more insects for a greater part of the season than dry scrub habitats. Marra discovered that redstarts compete for territories in lush, moist forests, where older, bigger dominant males win most of the battles. Less dominant males and most females end up eking out a meager existence in the dry zone. By the end of the season, birds living in the better habitat are in better body condition and leave earlier on spring migration than those stuck in the scrub. It stands to reason that this might affect redstarts' future success during the breeding season, but without the ability to match birds from winter to summer, Marra couldn't test this.

Then stable-isotope analysis came to his rescue. In two studies, Marra and his colleagues collected blood samples from redstarts just as they arrived in New Hampshire and Ontario, so carbon-isotope signatures in the samples would reveal the birds' winter habitats. (They tested blood rather than feathers because American redstarts molt just once a year, in the late summer.) Throughout their winter range, redstarts occupy one or the other of these habitats. So even though Marra couldn't look at the same individual birds in both winter and summer, he could tell in which habitat birds he followed in the summer had spent the previous winter. The results, published in *Science* in 1998, were profound.

Using carbon-isotope ratios from the birds arriving on the breeding grounds, Marra found that males that lived the good life in winter arrived on their breeding grounds as many as two weeks earlier than their less fortunate fellows. This is huge because in most migratory bird species, early birds enjoy greater reproductive success than late-comers, and this was borne out in Marra's redstart studies. Compared to late-comers, early-arriving male redstarts paired with females (which generally start arriving a week or so later than males) sooner, and more often paired with females coming from high-quality winter habitats, suggesting they enhance their success by mating with females in the best condition. Down the road, this head start translates into more offspring that fledge sooner in the season. This gives their youngsters more time than others to fatten up before undertaking their first, grueling migration in the fall. And, if these birds get to their wintering areas in better condition as a result, they may have a better shot at snagging high-quality winter territories. But this remains to be tested.

Why is this important? The coastal mangrove forests and tropical lowland forests that give some American redstarts such a winter boost are rapidly being lost to human uses. As the best wintering habitats disappear, more and more redstarts will be forced to struggle for a living in the scrub habitat left to them. This, in turn, will lead to population declines because birds wintering in scrub have lower overwinter survival rates and produce fewer young during the breeding season.

Victims of Success

As every human parent knows, raising kids, however rewarding, is also a costly, stressful affair. It is no different for bird parents. In a study published in *Science* in 2004, Marra and his student Ryan Norris demonstrated this for American redstart fathers, which share parental duties, including feeding young, with their mates.

American redstarts molt once a year, after the breeding season. Molting is expensive—imagine replacing your entire wardrobe annually—for birds in terms of energy instead of dollars. And it turns out that male redstarts that invest most heavily in producing young have less energy to spend on replacing their feathers.

Marra and Norris looked at stable hydrogen-isotope signatures in the feathers of known males at Marra's Ontario study site to determine where they molted the previous fall, which was impossible to find out any other way. Sixty percent of the males molted on the breeding grounds before embarking on migration. Forty percent, however, molted during migration, forcing them to stop for about a week along the way—and these were the guys that had raised the most young during the breeding season. Further, males that raised their young late in the season molted farther south than the early birds.

The upshot of all this is that male redstarts that molt during migration may arrive later in the tropics and find the best winter habitats—moist forests buzzing with bugs—already spoken for. This is bad news because, as we learned earlier, spending the winter in the low-rent scrub district doesn't bode well for a male's reproductive prospects the next summer.

And there's another twist. Male redstarts sport red-orange feathers that reveal their quality as mates and fathers to females. In many birds, females prefer to mate with the most brilliantly colored males—those that can afford to produce the most pigments that paint their feathers. Marra and Norris found that the farther south a male redstart molted, the paler his red-orange feathers, further diminishing his hopes of future breeding success.

Stable-isotope studies like these are shedding unprecedented light on previously obscure aspects of the lives of many animals and providing much-needed information to aid in their conservation. New forensic applications are also emerging. Scientists can trace the geographic origins of cocaine, for instance, to help them identify trafficking routes, and may similarly be able to pinpoint where microbial biological warfare agents were produced in the event of a terrorist attack. Stable isotopes sound as dull as wooden knives, but their analysis is among the sharpest cutting-edge tools in the modern biologist's kit. Z

FLORIDA'S Crowded Cat

BY HOWARD YOUTH

Despite rampant development in their habitat, endangered Florida panthers' numbers are increasing.

Heading south on Florida's I-75 from Tampa to Naples, traffic oozes with countless sun-sparkled sedans, silvery SUVs, and trucks filled with the trappings of a large state undergoing big changes. Tractor-trailers carrying turf rolls, two-by-fours, masonry, and ornamental palms pull off the highway, replaced by dump trucks heaped high with palmetto brush cleared from construction sites. From frontier to vacationland to home for 17 million people, Florida now welcomes some 1,000 new residents each day.

Instead of new tourist attractions, signs trumpet new housing developments with names like The Preserve, Malibu Lakes, and Cypress Falls. In the midst of this human circus, it's easy to forget that Florida provides the last refugia for dozens of endangered and threatened species and subspecies. The king of them all is the Florida panther, an apex predator and the last of the eastern pumas, or cougars.

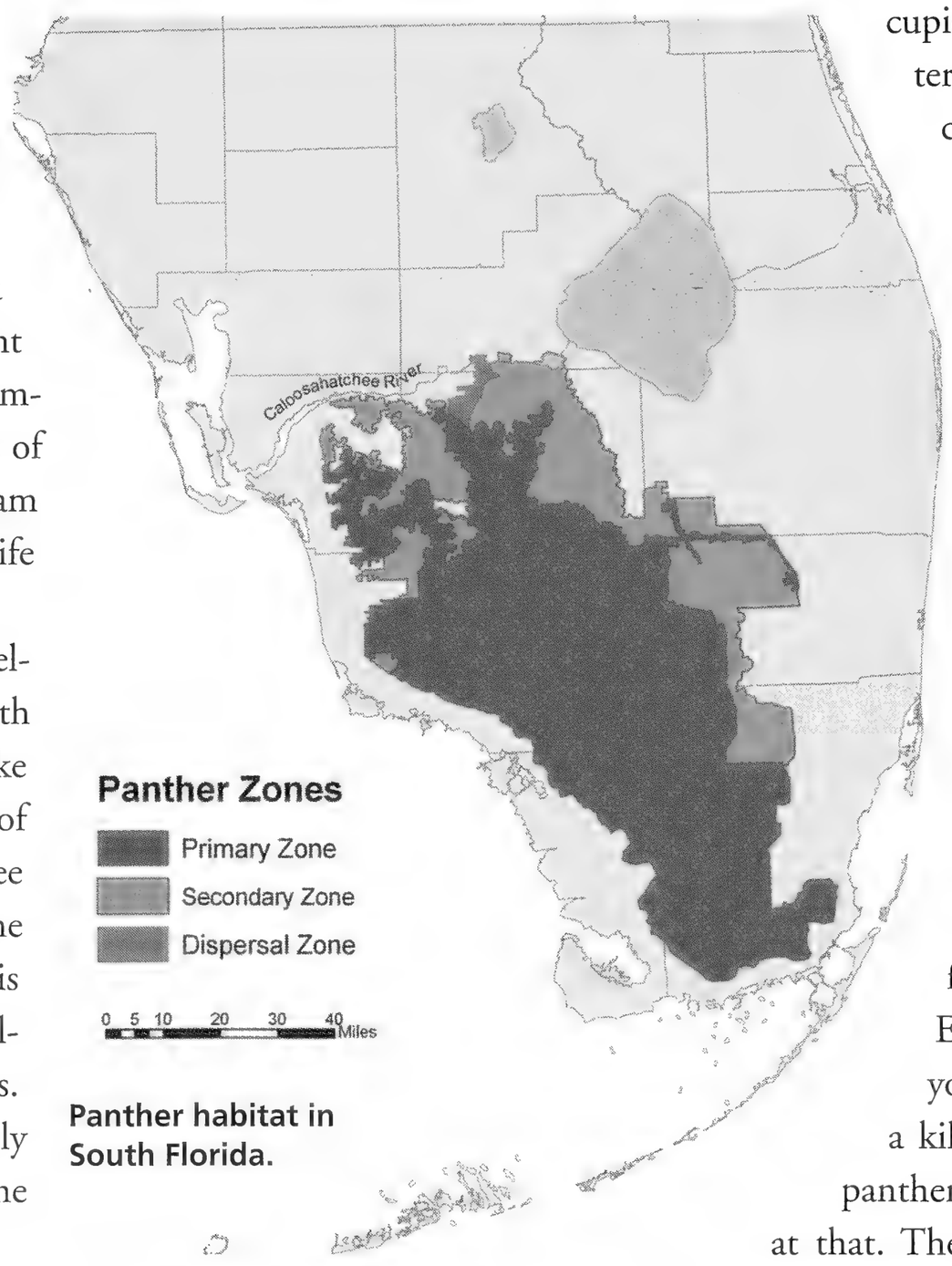
The Florida panther (*Puma concolor coryi*) once lived across the Southeast United States, and its range joined that of other puma subspecies to the north and west. Now endangered with extinction, this reddish-brown, up to seven-foot-long phantom is pigeonholed into just five percent of its historic range, making its last stand in Florida's southern tip. As it beds down by day and travels and hunts by night, the panther lurks in the shrinking shadows of Florida's building boom. But for how much longer?

The Florida panther was listed as endangered in 1967 by the U.S. Fish & Wildlife Service, and received thorough federal protection with the 1973 enactment of the Endangered Species Act. Over the decades, as the panther population shrank, conservationists realized that saving an animal that can roam 12 miles a night takes more than a few large parks and protection from hunting. It takes a multi-disciplinary marriage of genetics, conservation biology, land-use planning, and veterinary science. While the panther's odds don't always seem great, thanks to strong conservation efforts the known Florida panther population is now more than double what it was 30 years ago.

Big Cats, Big Cities

After battling more than three hours of heavy traffic, I find Darrell Land standing in his Naples office. I'm lucky: For up to 12 hours each week he's far above it, circling in a single-engine Cessna 172 to pinpoint radiocollared panthers with radiotelemetry gear. This tiring work is just one of Land's responsibilities as panther team leader for the Florida Fish and Wildlife Conservation Commission (FWC).

On Land's office wall hangs a satellite photo of South Florida stippled with hundreds of yellow dots that look like giant pollen grains. A huge smear of spots runs right over the Fakahatchee Strand State Preserve, indicating the striking number of times Land and his colleagues have locked onto radiocollared cats there over the last 25 years. But that doesn't mean panthers only pop up in natural areas. As he shows me the map, Land explains.



Panther habitat in South Florida.

Randy Kautz et al./USFWS

"They use practically every habitat out there in one shape or form, as long as it provides all the elements they need for food, denning, and stalking cover," Land tells me. "Young males that don't know where they're going end up in the darndest places. They find thick cover, wait until evening, then start working their way out," he says. Cover can include a copse of trees in suburbs, a thicket on a ranch, a citrus grove, or a stand of introduced Brazilian pepper bushes.

To illustrate his point, Land points to a spot on the map noting that a panther was located in the late 1980s right near the building in which we stand. Although Naples lies west of the core part of the Florida panther's range, wandering cats have popped up in areas much farther afield. Last year, for example, Land and his colleagues located a radiocollared male almost as far north as St. Augustine, within 100 miles of the Georgia border. Since 1988, four other radiocollared males and at least five other panthers—detected via their tracks, pictures, or roadkills—have been located north of the Caloosahatchee River, which is considered roughly the north end of the panther's current breeding range. Over the last 30 years, however, no panther breeding, nor any female panthers, have been noted north of the river.

Panthers are solitary and seldom meet up with others of their kind, except during brief mating encounters and the 14 months it takes for females to raise their cubs to independence. While young females usually stay inside or close to their mothers' home ranges, newly independent males have to find unoccupied areas or risk the wrath of resident, territorial males. In fact, the number-one cause of death among panthers is territorial males killing others that wander into their declared space. With each resident male holding an average home range of 250 square miles, and with each territory likely overlapping that of several females and their young, a few panthers cover a lot of real estate. "Certainly south of Lake Okeechobee, all of the areas that could support panthers are supporting panthers," says Land.

On average, young males disperse 25 miles, but the longest recorded peregrination was by a male that wandered 139 miles in seven months, followed by another trek of 145 miles. Except when females are tending their young or when an individual remains at a kill site to savor its prey for a few days, panthers are not only loners, but restless ones at that. They bed down in different locations at night, and patrol, scent mark (by urinating on piles of ground litter), and hunt throughout their home ranges. As they move around, many—especially young, dispersing males—risk encountering the panthers' second-greatest killer, cars and trucks. Between five and ten panthers die on Florida roadways each year (and between January and March 2006, five panthers had already been killed on Florida roads). "The number of road kills is up," Land told me, "but

Bruce Coleman Inc./Tom Brakefield

Like many large cats, Florida panthers stalk their prey, then burst into speed and pounce on it at an opportune moment. They often eat larger prey, such as this white-tailed deer or feral hogs, over several days and hide portions for later consumption.

that's not surprising given that we believe the population has doubled or tripled since the 1980s."

Ideal panther habitat has minimal human disturbance, dense vegetative cover (such as palmetto), and ample prey, especially white-tailed deer (*Odocoileus virginianus*) and feral hogs (*Sus scrofa*). Panthers also hunt northern raccoons (*Procyon lotor*), nine-banded armadillos (*Dasypus novemcinctus*), marsh rabbits (*Sylvilagus palustris*), and American alligators (*Alligator mississippiensis*). Pets sometimes fall onto the menu as well. A few weeks before my visit, I spoke with Land on the phone and he told me that his office occasionally receives reports of panthers killing domesticated emus and turkeys, and that in the last few weeks, a few dogs had been attacked—the first such reports since the late 1980s. "Most of the depredation events," he told me, "are more of a chance meeting and not a true act of predation. Once panthers are locked in on something like that, it's kind of hard for them to break their attention. Unfortunately, we might be expecting to see more of these kinds of encounters given the tremendous increase in the human populations and small but steady growth in panthers, although the cats are hitting the ceiling in terms of space," said Land.

His prediction seems to be proving true during our meeting, which is cut short by incessant beeping. "I'd better get this," Land says, reaching for the black radio sitting on his desk. A woman's voice tells him that a domestic turkey was reportedly killed the previous night, and that she suspects Panther 79, which frequents the area. "All the classic signs [indicate] that this was a panther, not a bobcat," says the voice. (Land later tells me that his colleague suspected the panther because she found panther tracks and could hear the cat's radio signal.) "The media [are] on the way. We need to get someone from the state out here to talk with them," crackles the voice.

I leave Land to his work and head east from Naples. To go from the sprawling city to the heart of panther country takes just half an hour.

Bring on the Texans

Genetic sleuthing has played a major role in the panther population's recent growth. From the 1970s into the '90s, only 20 to 50 Florida panthers were thought to survive. Confined and dwindling, they had become inbred. Visible signs of their lack of genetic variation included crooked tail tips and cowlicks of fur on their backs. But more serious problems lurked beneath the surface. JoGayle Howard, a reproductive physiologist at the Smithsonian National Zoo's Department of Reproductive Sciences, has helped monitor the reproductive health of Florida's panthers for more than 20 years. She was shocked when she began examining panthers in 1985. "It turns out they had the worst sperm quality of any cats we'd found—even cheetahs. They were sort of a textbook of abnormal sperm. We'd never seen such high percentages of sperm defects," says Howard. Florida panther males had 94 percent abnormal sperm.

> From the 1970s into the '90s, only 20 to 50 Florida panthers were thought to survive.

Another problem came to light when Howard and her colleagues examined panther acrosomes, membranes that cover sperm heads and release enzymes that bore into eggs during fertilization. Forty-two percent of all the Florida panther sperm they analyzed had abnormal acrosomes. Puma samples from other regions had far lower

One population model projected that the panther might go extinct within 20 years.

percentages: 19 percent in Colorado, ten percent in Texas, and just six percent in Latin America.

Another worry was the growing rate of cryptorchidism in male panthers—the failure of one or both testes to descend from the body. "Around 1985, about 30 percent of the population's males had only one descended testis," says Howard. "By the late 1990s, 80 percent of the population's males had one descended testis, and we were also starting to see males with no descended testes that were totally infertile." In addition to these reproductive woes, an atrial septal defect—a hole in the wall between two atria that does not allow proper blood flow through the heart—began to show up in Florida panthers. This caused heart murmurs and could have proven fatal to many of the inbred cats.

In 1994, Howard and other geneticists, biologists, and land managers met at the White Oak Conservation Center in northeastern Florida to plan for the panther's future. At the time, one population model projected that the panther might go extinct within 20 years. "It was a very contentious period," recalls Howard. "Some of the field guys said, 'Hey, these cats are breeding. There's nothing wrong.' They had doubted the studies. Then the data were presented and they said, 'Okay, what are we going to do about this?'"

Bruce Coleman Inc./Patrick M. Lynch

Signs on highways in South Florida warn motorists to keep an eye out for panthers.

The next year, 1995, eight female pumas were captured in Texas and released into panther habitat in South Florida. Texas cats were chosen because they were the closest genetic fit, but were typically larger than Florida panthers. "We were worried that big Texas males would kill smaller Florida panther males, so it was decided to bring in just females," says Howard. Five survived and began breeding with the local males. The Texas females have since been removed from the Florida wilds, but not before they produced 20 offspring, which in turn gave birth to about 60 grand-offspring.

Pure Florida panther males average around 115 pounds; females average 75 pounds. The intercrosses—offspring of Texas and Florida cats—grew larger. In 2000, Howard collected samples from a treed, darted 154-pounder, a first-generation intercross male called Panther 79—the same one I heard mentioned on Land's radio. After she and her colleagues looked at sperm samples, they found that the Texas experiment paid off. "Many of the bad defects we had been seeing went away in the first breeding," says Howard. Panther 79 had only ten percent abnormal acrosomes, the same percentage as Texas cats.

There are no current plans to reintroduce more Texas cats, but panther conservationists now know they could if the panthers' genetic health heads south again. "The original plan was to get a flood of genes from Texas cats in there and see what happens," says Howard. "There's been no cryptorchidism seen after the genetic restoration," she says. Some critics say that the intercross cats compromise the genetic purity of the Florida cats. Howard does not think this is an issue. Neither do some other geneticists. The infusion of new blood certainly seems to have boosted the cats' productivity: The last published count from 2003 tallied 87 cats, not including kittens.

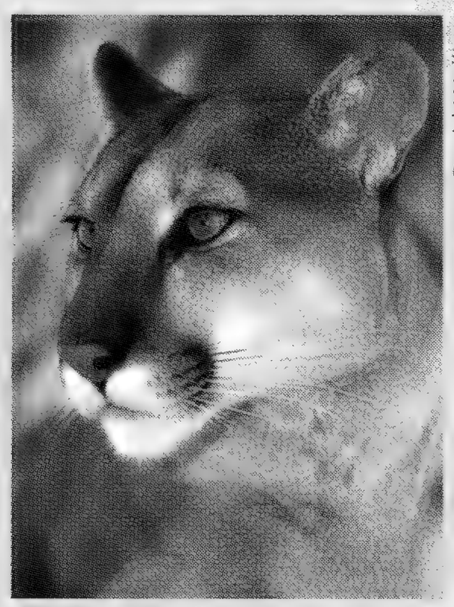
The Florida Space Race

The Endangered Species Act requires that plans be made for each listed species' recovery. On January 31, 2006, the third draft of the Florida Panther Recovery Plan was published. In addition to recommending steps to ensure the future of the panther, the plan provides a comprehensive summary of what is known, or not known, about these stealthy animals.

Reflecting recent criticisms, the third draft of the recovery plan mentions a weakness of the dotted map on Land's wall—years' worth

Is the Florida Panther REALLY a Distinct Subspecies?

In 2000, four geneticists working at the Laboratory of Genomic Diversity at the National Cancer Institute in Frederick, Maryland, published an article in the *Journal of Heredity* entitled "Genomic Ancestry of the American Puma." For their study, they collected DNA samples from



David Welling

315 pumas from various parts of pumas' extensive range, from the Yukon to Patagonia, and subjected them to genetic and phylogenetic analyses. For the last 70 years at least, taxonomists believed there were 32 distinct puma subspecies. This investigation revealed there are only six—and places all of North America's pumas, including the Florida panther, within the same subspecies, tentatively called *Puma concolor couguar*.

Further, the uniformity of the mitochondrial DNA and other genetic features suggests that North America's present-day pumas descended from a small group of pumas from eastern South America. Following the late-Pleistocene extinction of perhaps 80 percent of large North American mammals, these

Lynn M. Stone/www.naturepl.com

Florida panthers' hind legs are powerful and larger than their forelegs; they can leap up to 18 feet onto tree branches.

of data on radiocollared panthers that were mostly recorded during the day, the only time it's safe to circle a small plane low over hidden panthers. The 2006 plan reads, "Since almost all data from radiocollars have been collected during daytime hours...and because panthers are most active at night, daytime radio locations are insufficient to describe the full range of panther habitat use."

Over the last few years, controversy has swirled around the way some past panther research was conducted or interpreted and how it factored into land-use decisions. A 2003 report for the FWC entitled *An Analysis of Scientific Literature Related to the Florida Panther* states, "The conclusions that panthers prefer large forest patches and are reluctant to travel from forests are unreliable because the analyses excluded (without mention or rationale) a large fraction of the available data, ignored errors inherent in telemetry data, and did not rigorously compare used habitats to habitats available to the [radiocollared] panthers." The authors of the report also believe that some building projects were approved based on these questionable data, and note that over the last decade, there has been little progress in researching future panther reintroduction sites.

While there are no current plans to reintroduce panthers to other parts of their former range, the latest recovery plan states that an important part of the panther's recovery will be "expanding the known occurrence of panthers north of the Caloosahatchee River, if feasible, and identifying potential reintroduction areas within the historic range... ." The aim is to establish and maintain at least two other viable populations outside of South and south-central Florida. Potential reintroduction sites include parts of Arkansas, Mississippi, Alabama, and northern Florida. As a reintroduction site, central Florida is given low priority due to its heavy development, large human population, and extensive road network.

With only one isolated population, Florida panthers have no "medical insurance"—they remain vulnerable to disease outbreaks and other calamities. In 2002, five panthers tested positive for feline leukemia virus, and two of them died from the disease. The cats' wild

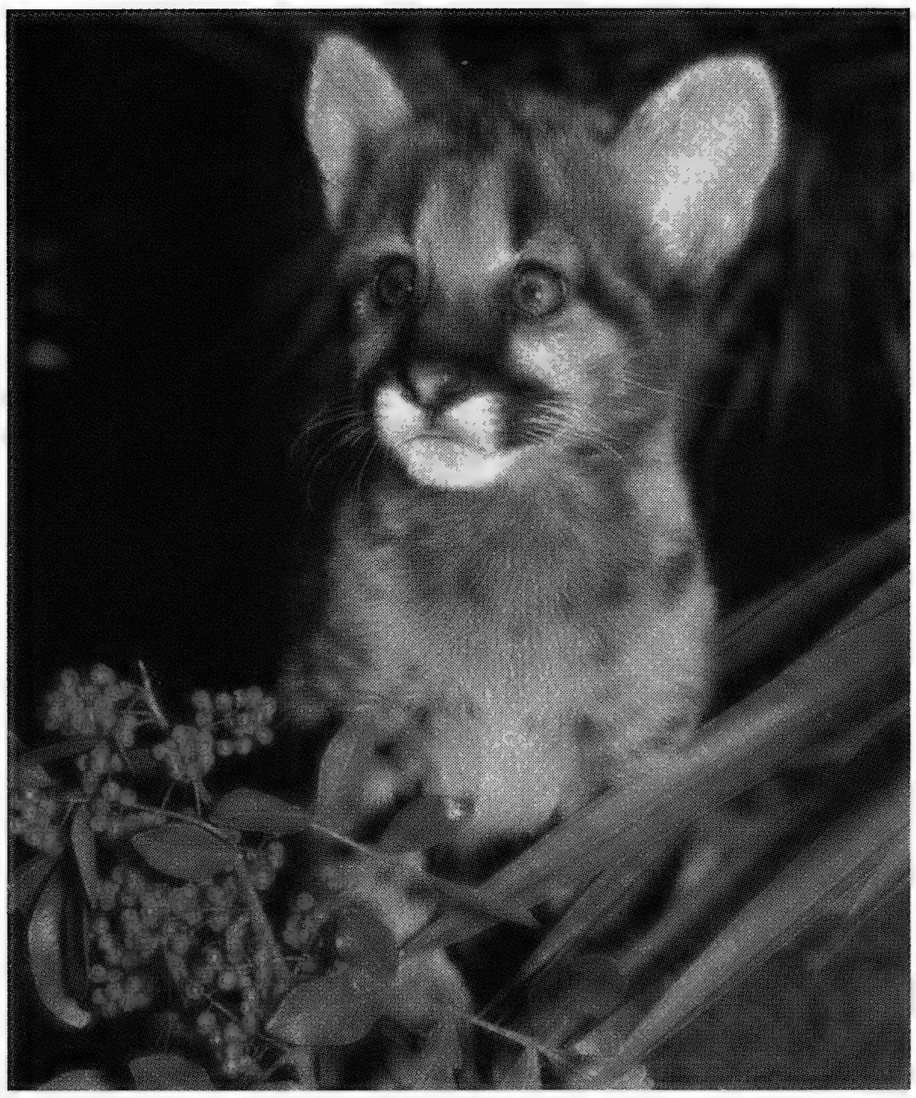
pumas recolonized North America between 10,000 and 12,000 years ago.

Did North America's pumas die out along with cheetahs and many other cat species, only to be replaced later by South American pumas? The genetic sleuthing seems to point in that direction. If so, pumas' return from South America, where they probably arrived from North America via the Panamanian land bridge about four million years ago, is certainly a case of "what goes around comes around."

If taxonomists accept the proposal that the Florida panther no longer be considered the separate subspecies *Puma concolor coryi* but rather part of the now-proposed North American puma subspecies, will it still receive Endangered Species protection? Probably. The *Journal of Heredity* study did acknowledge the Florida panther as an isolated, inbred population with genetic features different from others, and the third draft of the Florida Panther Recovery Plan states that "although the Florida panther is a subspecies, the protection it receives under the ESA [Endangered Species Act] is the same as for all other federally listed taxa whether they are species, subspecies, or distinct population segments."

—Howard Youth

hog prey can carry pseudorabies virus, a neurologic disease that killed at least one panther in the 1990s, while rabies, which is present in raccoons in some areas, claimed another. Radiocollared panthers are now vaccinated for feline leukemia virus and rabies. But there are other concerns as well: Veterinarians examining panther blood samples found antibodies to feline immunodeficiency virus and feline panleukopenia virus. Right now, none of these ailments pose a grave threat to the panther population, but it's not hard to picture a dire scenario, especially given that one of the downsides of inbreeding can be compromised immunity to disease.



Bruce Coleman Inc./Gail M. Shumway

Kittens' eyes turn gold as they mature.

Meanwhile, in the panthers' current breeding range, the walls of development are beginning to close in. Between 1985 and 2003, for example, three of the five counties that were home to breeding panthers—Collier, Lee, and Hendry—lost more than 368 square miles of natural or semi-natural habitat to agriculture and development, an area half the size of the state's largest lake, Okeechobee. And some projections estimate that South Florida's human population will grow by more than 50 percent by 2030. "I think any acre of open land out there is vulnerable to pressure," Land says. In many areas, agricultural lands, which are not considered conservation priorities but are used by hunting and moving panthers, are giving way to housing, malls, and other development. "From a conservation standpoint, we prefer the land [remains] in agriculture," says Land, "but economic pressures are too great. The profit you get from agricultural activity pales in comparison to direct conversion [of the land for development]," he adds.

But the news isn't all bad. "Some recent state purchases are starting to make a more secure jigsaw puzzle for the panther," says Land. In recent years, due in part to the state's $300-million-a-year Florida Forever land acquisition program and to required mitigation when developers are permitted to build in panther country, some important land purchases and easements have been, or will be, set aside.

From the late 1980s through the 1990s, for example, the state purchased 70,000 acres along the west border of the Fakahatchee Strand State Preserve, including the former Southern Golden Gates Estates development. There, cypress forests were logged in the 1950s, and canals, roads, and 2.5-acre plots were carved into the landscape in the 1960s as part of an operation to sell seasonally flooded swampland to unsuspecting buyers. The area, now the Picayune Strand State Forest, is being restored as wildlife habitat. Not far north, at the boundary between Hendry and Collier counties, lies the 32,000-acre Okaloacoochee Slough State Forest, home to Florida panthers, Florida black bears (*Ursus americanus floridanus*), and other threatened and endangered species.

One important property that may soon be purchased with Florida Forever funds is the Babcock Ranch, a 91,000-acre mosaic of habitats that would link four other protected properties, forming a band of conservation land that nearly stretches from the Lake Okeechobee shoreline west to the Gulf Coast. These vital areas lie just north of the Caloosahatchee River and may some day provide a gateway for northern expansion of the breeding panther population.

Private mitigation banks and permanent easements will also help protect some panther areas, offsetting at least some of the changes wrought by planned development. The 5,000-acre Ave Maria University and mixed-use development planned just north of Fakahatchee Strand State Preserve will claim large agricultural lands adjacent to areas where radiocollared panthers have been detected. As part of Collier County's Rural Stewardship Plan, the developers will be required to set aside large permanent habitat blocks that will protect nearby panther habitat.

***

Several large pieces of conservation land form the current core of panther country, and I drive between them after my meeting with Darrell Land. As I head south on State Road 29, on my right I pass the 2,400-acre Florida Panther National Wildlife Refuge, followed by the Fakahatchee Strand State Preserve's 80,000 acres. On my left sits the 730,000-acre Big Cypress National Preserve, now marked by U.S. Department of Interior signs, although here and there I spot amid the foliage rusted real estate signs that could have spelled a different future for the land. Instead of houses, I find Spanish moss-draped cypress, cabbage palm, and a sprinkling of royal palm sheltering basking alligators below and croaking cormorants, egrets, and herons above.

After a rumble strip, flashing lights, and a series of signs warning, "Panther crossing next 7 miles," "Entering panther habitat," and "Speed limit 60/night 45," I pull off the road where chain-link fences frame a vine-plastered concrete underpass. Panthers and other wildlife find safe passage beneath the roadbed using this and almost 30 other underpasses, or wildlife crossings, scattered along this road and I-75. These structures serve as cat crosswalks in what is, in essence, the panthers' downtown.

From my tranquil vantage point, the future seems bright for Florida's panther. But much of Florida is not like this. Across the state, the human rush hour is just beginning. When sunset arrives outside protected areas, denning panthers will stir, then wander between clusters of new houses and endless lines of headlights in search of prey. Z

—Contributing editor Howard Youth's recent ZooGoer *articles have explored the world of sharks, and Florida's exotic reptiles.*

Books, Naturally

Smithsonian Intimate Guide to Human Origins

Carl Zimmer. 2005. Smithsonian Books and HarperCollins, New York. 176 pp., hardbound. $29.95.

Every book on human evolution is outdated before it reaches bookstores. Since the *Smithsonian Intimate Guide to Human Origins* was published at the end of 2005, several new findings have emerged, but they amplify rather than change the story Carl Zimmer tells in this engaging review of what is known about the evolution of our species. In fact, Zimmer and his publishers have done an amazing job of making this book as current as humanly possible, with several references to scientific papers published earlier in 2005. And through his blog, called The Loom (**http://loom.corante.com**), Zimmer continues to weave tales about new scientific discoveries related to human origins as they are reported.

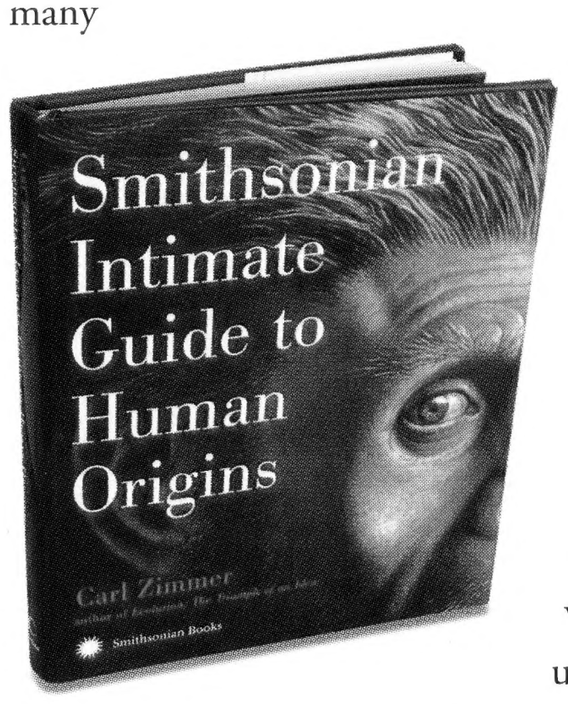
"Intimate" seems a strange word to describe a book that might easily serve as a textbook, albeit one of the best ever written on the subject. On reading it, however, intimate is most appropriate to the author's style. Zimmer is an award-winning science writer, with such marvelous books as *Parasite Rex* to his credit. (See my review at **www.fonz.org/review296.htm.**) He writes as if he were telling his story around the dinner table and enthralling even people who profess little interest in science.

Consider Zimmer's description of Neanderthals: "Their faces were long, their noses huge. They were stocky and muscular... Picture an Olympic shot-putter with Cyrano de Bergerac's nose."

Or this, in reference to the importance of binocular vision: "Thanks in part to our forward-facing eyes, we can use our hands to carry out delicate, complex tasks. To appreciate just how important they are, imagine going to the hospital for brain surgery. You wouldn't be happy to find that your surgeon had eyes like a pigeon, pointing out from the sides of his head."

And in speaking about the scientists who study human origins, Zimmer writes, "When paleoanthropologists discover a new species of ancient hominid, even a paltry collection of bone fragments can send them into ecstatic fits."

Zimmer begins his exploration of human origins, as any book about evolution must, with Charles Darwin's prescient ideas about our relationship to other apes and ends it with well-grounded speculations about how human beings might continue to evolve in the future. Along the way, he explains the most current thinking about how hominids (a group that includes *Homo sapiens* and their now-extinct closest relatives) split from other apes; progresses to tracing the emergence of bipedalism, tool use, and big brains among hominids; then shows how and when hominids of various species dispersed from Africa through Europe and Asia. Finally, Zimmer reviews the origins and expansion of *Homo sapiens*, the hominid species that ultimately replaced all others and came to dominate the Earth. Noting that *Homo sapiens* may have been responsible for wiping out other *Homo* species as we have so many other species, Zimmer says, "It would be ironic indeed if it turned out that three of the first species to encounter the sharp blade of our competitive edge were our closest relatives."



Paralleling his voyage through evolutionary time, from the earliest appearance of fossil primates some 65 million years ago to the present, Zimmer sketches the scientific advances of the past few hundred years that have made our current understanding of human origins possible. When Darwin was thinking about human evolution, he had little evidence to go on. Only some fossil tools and a handful of Neanderthal bones had yet been unearthed, for instance, and visits to the London Zoo were his only contact with a great ape. Since then, scientists have extracted every insight currently possible from an array of fossil primates from Africa, Europe, and Asia, studied the behavior and ecology of all of the great apes, and, most recently, decoded the genomes of both humans and chimpanzees so they can begin to identify the genetic changes that make us human.

In sidebars, Zimmer delves more deeply into several topics, providing more background without interrupting the narrative flow of the main text. "What is DNA?", for instance, offers a quick refresher on this all-important molecule, while "Myth of the Missing Link" explains why this term, so popular with headline writers, refers to a concept that is simply wrong. "Genetic Engineering: A New Kind of Evolution?" speculates on how this new technology might affect our human future.

Human Origins is also beautifully illustrated with color photographs, drawings, maps, and charts that illuminate the text. It's surprising how much skulls, skeletons, and stone tools look like works of art in so many of the book's stunning photographs.

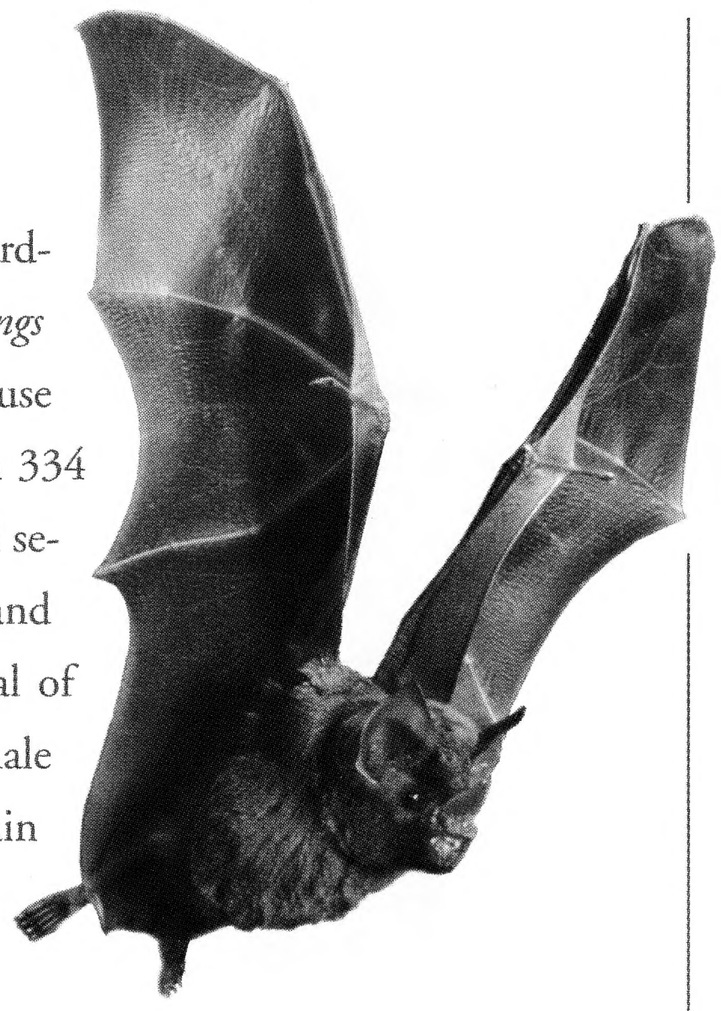
Clear, concise, educational as well as entertaining, this book will appeal to adults who want to update what they learned about human evolution in college. It also offers a great introduction to the subject for college, high school, and even middle school students who are curious about where they came from—and it just may inspire them to a career in this fascinating science.

—Susan Lumpkin

BioAlmanac

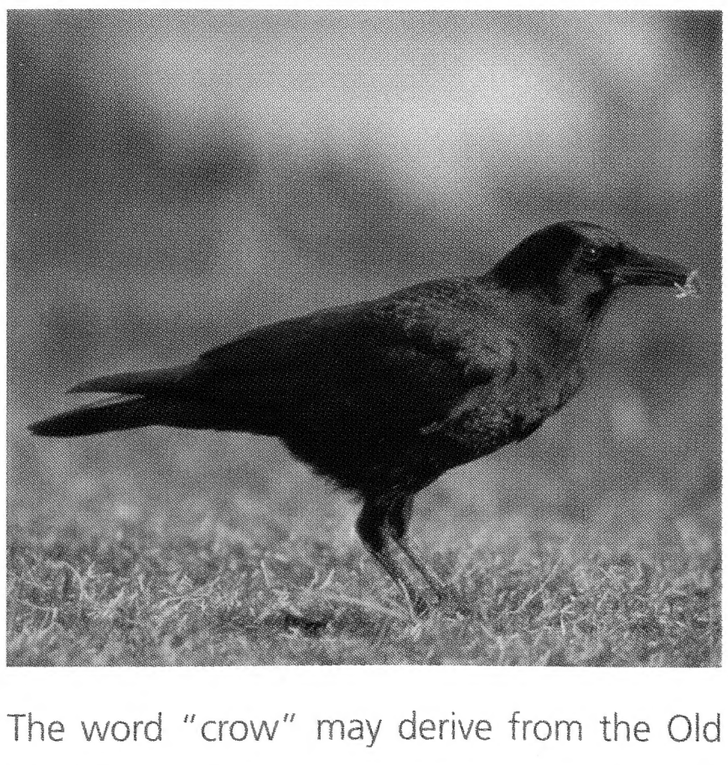
by Shannon Lyons and Allison Hagerman

Too Sexy for a Brain



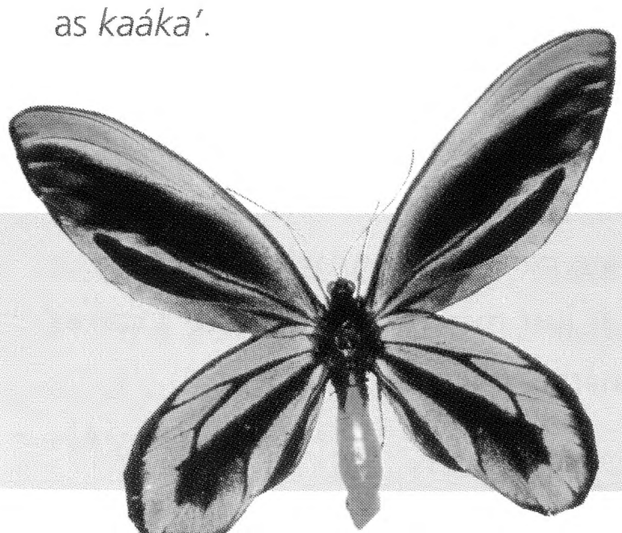
Male bats can be sexy or smart but not both, according to a recent study published in the *Proceedings of the Royal Society B*. Scott Pitnick of Syracuse University and his colleagues examined data on 334 species of bats (order Chiroptera) to see if sexual selection influenced the evolution of male brain and testes size. Brains and testes require a great deal of energy to maintain, and the study showed that male bats with larger-than-average testes sacrifice brain size, and vice versa. For example, the testes of male silver-tipped myotis bats (*Myotis albescens*) are 6.7 percent of their total body mass, but their brains account only for 3.2 percent. They make more than double the investment in reproductive organs than in brain tissues so they can woo the promiscuous females of their species away from other suitors. In species with monogamous females, the reverse is true: Males tend to have larger brains and smaller testes.

What's in a Name?



The word "crow" may derive from the Old English word *crawe*, an onomatopoetic reference to the black-feathered bird's noisy squawks. Various other cultures also named the crow for its caws—the Thai call it *kaa*, for example, and the Pawnee Indians refer to it as *kaáka'*.

For centuries, "crow" has also found its way into other words and catchphrases. Chaucer used the term "crow's foot" to describe a wrinkle around the corner of the eye in his poem *Troilus and Criseyde*. The crowbar was so named because it also resembles a crow's foot. The phrase "as the crow flies" literally refers to the direct path along which a crow may travel from one point to another and probably originated around the early 1800s. And the expression "to eat crow" likely made its debut during the War of 1812, when, as the story goes, an American soldier wandered into British territory and shot a crow, then was forced to eat a bite of the unsavory bird by a British officer. The American later made the British officer do the same, thus spawning a phrase that now means to suffer great humiliation.



The Queen Alexandra's birdwing (*Ornithoptera alexandrae*) of Papua New Guinea is the world's largest butterfly. Females' wingspans sometimes exceed nine inches.

How Do Honeybees Find Food?

Flowers advertise their stores of nourishing pollen and nectar to honeybees (*Apis mellifera*) with tempting scents and ultraviolet patterns on their petals. If a honeybee finds a particularly rich or hidden food source, it returns to its hive and performs one of three "dances" to communicate the discovery to its hive mates: The round dance, which entails walking in a circular pattern repeatedly, probably signifies that a food source is close; the semicircular sickle dance is done for food sources at intermediate distances; and the more complex waggle dance, in which the bee walks in a figure-eight pattern and shakes its body, probably imparts the distance and direction of a food source that is farther away.

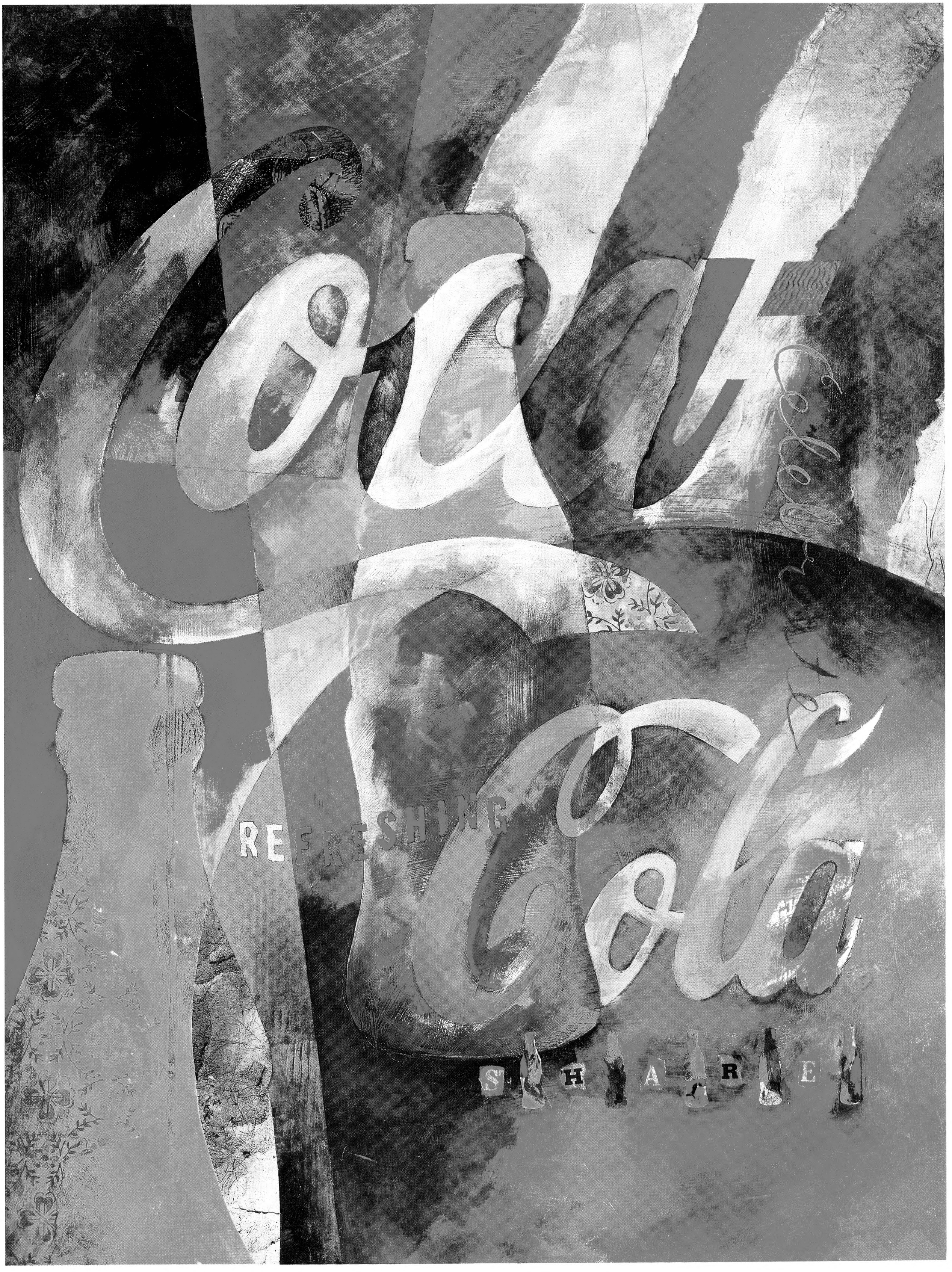
Fact or Fiction: Snakes Can Be Charmed

Sss-surprise! Despite the popular belief that some snakes in India, Africa, and the Middle East are hypnotized into a "dance" by the exotic hum of a charmer's flute, they are not actually charmed. Scientists are not certain how snakes hear; most agree that snakes can detect the vibrations emanating from music, but probably don't hear sounds the same way that humans do. Several studies suggest that cobras respond to the visual cues of a snake charmer rather than to the melody of his flute. When a charmer removes the lid of the snake's wicker basket, the incoming light might startle the reptile and provoke it to rise; it may then feel threatened by the flute, and mirror its movements by swaying back and forth.

In Season

Mating season for the Chesapeake Bay's blue crabs (*Callinectes sapidus*) begins in May, in northern parts of the bay with low salinity, and continues until October. Female blue crabs, which have red-tipped claws, can use the sperm from a single male to fertilize several clutches of eggs. After mating, they migrate to southern regions of the Chesapeake closer to Virginia and the Atlantic Ocean, where the water's high salinity facilitates larval development. There, each female spawns, or lays, between 750,000 and eight million eggs, depending on her size. For every one million blue crab eggs spawned, only one will reach maturity. Most succumb to fungal infections, suffocation in stagnant waters, or predation by fish, birds, adult blue crabs, and humans.

Short-tailed bat: Bruce Coleman Inc./Joe McDonald. Crow: Bruce Coleman Inc./Norman Owen Tomalin. Butterfly: The Natural History Museum, London. Honeybee: Bruce Coleman Inc./Kenneth Deitcher.


REFRESHING
SHARE

Everything's better with Butter.

Only one thing could make an evening of sampling gourmet fare from Washington's finest restaurants even better. A giant panda cub! Join Tai Shan (affectionately known as Butterstick) on May 18, 2006, at the Smithsonian's National Zoo for an unforgettable night of food and fun. Tickets are on sale now at **www.fonz.org/zoofari.htm**.

National ZooFari 2006: Black & White Night

FONZ
Friends of the National Zoo

Friends of the National Zoo, 3001 Connecticut Avenue, NW, Washington, DC 20008, **www.fonz.org**